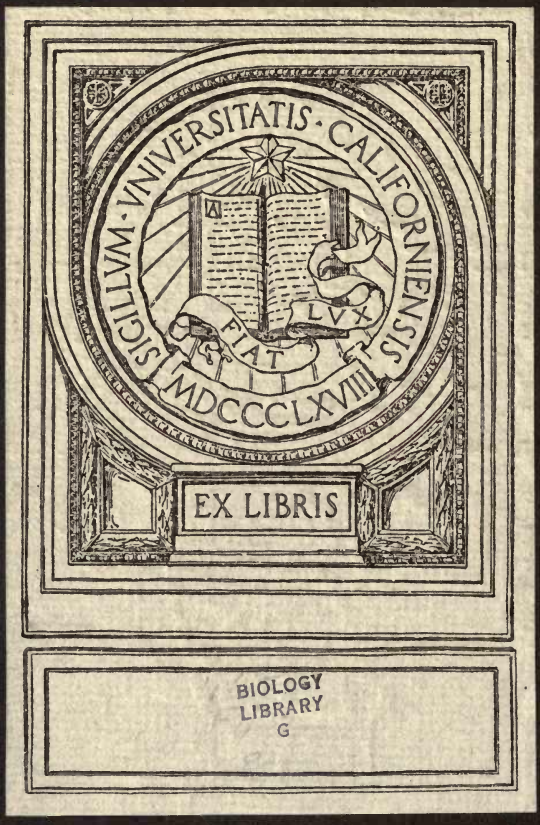

BULLETIN

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AN AID TO A COLLECTOR OF THE CŒLENTERATA AND ECHINODERMATA OF NEW ENGLAND.

BY J. WALTER FEWKES.

I. INTRODUCTION.

It is very difficult for one wishing to study the development or anatomy of any marine animal to know when and where to find the eggs, young and adult. It is also not easy to recognize the young of certain members of our marine fauna, when they are found. It is also difficult to identify the adult.

The following pages are intended to serve as a help in the identification of the adults and young of the more common Cœlenterata and Echinodermata of the waters of New England. They are written for those[1] who wish some means by which to learn the names and the general external characters of the common forms of life, which have their homes on our coasts. The author follows with admiration the plan adopted by Philip Gosse in a too little known Manual of Marine Zoology, which without claim for originality he has simply modified to meet the necessities of the present case. The lament which Gosse makes that the information necessary to identify the common animals of Great Britain is scattered through monographs, many of

[1]This key to the identification of New England Cœlenterata and Echinodermata was prepared for the members of the Teachers' School of Science who attended my course of lectures in the winter of 1890. It is intended to be used as an introduction to a study of their notes on some of those lectures.

which are in a foreign tongue, may with still greater emphasis be repeated by us in New England, especially as far as the young of our marine animals are concerned. These chapters are written as introductions to larger works and more exhaustive monographs.

These pages may be of use to those who, while not beginners, have yet made such progress in the study of our marine animals as to wish some guide in the determination of a few of the different specific forms of lower marine life which he meets. It is not a monograph nor an original contribution to the subject. It is an aid to the collector, and is intended to meet certain difficulties which even the professional naturalist encounters in the identification of animals.

II. KINDS OF COLLECTING.

It is well for the student of our Cœlenterata and Echinodermata to be familiar with methods of collecting in three different regions.

A. Shore Collecting, or collecting of animals from the littoral zone.

B. Dredging, or collecting from depths below low tides.

C. Surface Collecting, or collecting from the surface of the water.

A. Shore Collecting.

In order to study the marine larvæ of jellyfishes and starfishes, it is often necessary to raise them from the egg. The capture of adults with ova is therefore a desideratum. The apparatus employed in shore collecting is very simple. A jar or pail for specimens, a shovel or trowel and a hand net are all that is required. The time for collecting is generally at low-tide, and as more animals are washed up after rough weather, the last days of a storm give the best results.

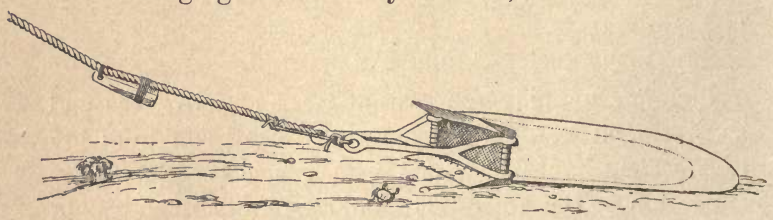
On the line between high and low tide many genera of Echinoderms are found thrown upon the beach. Several Holothurians are found by digging in the flats.

The hydroids of jellyfishes and many of the Actinozoa occur in sheltered pools or caves just below low tide, and can easily be captured with a hand-net by a little wading. I have found the roots of our large Laminaria, or "Devil's Apron String," when placed in pure water and allowed to stand for a length of time, to give up a rich collection of young starfishes, some young Holothurians and many Ophiurans. Hydroids are abundant on certain seaweeds washed on the shore after a storm. It is well to transfer to our aquarium any object which when thrown on the beach has apparently been recently torn from the bottom or has the appearance of having been floating for a considerable time. These objects almost invariably will be found to be the home of a rich cœlenterate life.

B. Dredging.

The use of the dredge for the capture of the adults with ova cannot be neglected. The great majority of the adults and some of the young are taken in this way.

For dredging down to fifty fathoms, which is the limit



DREDGE FOR USE IN SHALLOW WATER.

of the animals treated of in this volume, a very simple dredge can be constructed by any blacksmith, and with a rope suitable for that purpose, will cost only a few dollars.

The dredge which I have used consists of a rectangular

frame made of iron of about twice the length of the height. The longer sides are made of flat bars which are more or less flaring. The rope is attached to two iron arms which move readily on their attachment to the frame and which have eyebolts at their free ends. The rope is firmly attached to one of these; the attachment to the other is by means of a smaller cord which will break when the dredge is caught, and allow the obstruction to be avoided by a change in the direction of the dredge. A weight is fastened to the dredging rope about five feet or a fathom from its junction with the dredge, to insure success in the dredge being dragged along horizontally. The length of the rope used must be somewhat longer than the depth of the sounding, and may be determined by the various conditions, as depth of the water, or time of the tides. The simple drifting of the large sail boat is force enough to work with a small dredge.

The net of the dredge is fastened to the iron frame, and is protected by a coarse canvas bag which prevents the meshes from being torn. The time the dredge may be left out must be determined by experience.

The most convenient place[1] for shore collecting is at Revere Beach and Nahant. The piles of Beverly Bridge furnish many Actinoids and Hydroids.

The dredging off Nahant is among the best in New England. Off Race Point, Provincetown, a rich harvest may be expected. The channel between Castle Hill and Conanicut Island is rich in certain genera, especially Arbaciæ and Echinarachnii. Dredging off Baker's Island is good.

The ledges in the middle of Plum Island river off Great Neck, Ipswich, and the adjoining deep water are good places for Asteroids and Echinoids.

Grand Manan is one of the best collecting places for lit-

[1] This is written for teachers living near Boston.

toral and shallow water animals on our coast. The "ripplings" furnish one of the best places for surface genera. At Eastport the channel between the Old Friar and Treat's Island is the richest known to me. The surface fishing there is good. Newport affords an abundant surface fauna which is characteristically southern in its facies.

Surface fishing, as distinguished from shore collecting and dredging, pertains to those animals which habitually swim at or very near the surface of the sea.

The fauna of the ocean surface is known as the pelagic fauna, from the Greek word, πέλαγος, meaning the sea. Since, however, the word pelagic from its derivation means the sea as a whole without special reference to the surface, the adjective æquorial, from "æquor" the surface, would more accurately designate the character of the fauna with which a part of our subject deals.

The methods of surface fishing are easily acquired and require no complicated outfit. A simple hand or drag-net made of muslin or bolting cloth for collecting; a water bucket or jar for the reception of specimens captured; and a boat to seek out the tide eddies where the animals which we are to study are most common, are all that is necessary. This method of fishing needs but a few general hints for successful prosecution.

The best collecting ground must be learned from experience. Tide eddies, edges of currents, sheltered nooks and small bays into which the floating life is accidentally lodged or driven by the wind and tides, are most prolific in the abundance of surface life. Wherever the tidal currents collect flotsam of any kind, there, if not too far from the open ocean, one can look with promise of success for wealth of æquorial life. The same causes which bring inanimate objects into these places will lead to accumulation of floating forms of life in the same localities.

The time for profitable collecting is influenced by the

tides, the winds and some unknown conditions. Other things being equal, at the mouth of a bay as at Newport the full tide is best for oceanic larvæ, or if one is situated near a small bay where floating material is caught during an ebbing tide, about an hour after the tide begins to fall will generally yield the best results. The first hour of the flood is commonly the poorest time for surface collecting and the last of the ebb generally gives us the larvæ of the littoral fauna rather than the oceanic. The best condition of the sea in which to collect surface animals, adult as well as larvæ, is during a calm. When this happens in Narragansett Bay at high tide, after a strong south, or southeasterly wind we may, if ever, expect to find a most abundant and varied life captured in our nets. Smooth places on the surface called "slicks" afford good collecting. Night-time during that calm state of the water which commonly takes place between eight and nine o'clock, is one of the best hours for successful surface fishing. The amount of "phosphorescence" in the water is an indicator of the abundance of surface life. The character of the animal life which causes the glow can be in a measure made out by the color of the emitted light.

As most of the larvæ which are treated of in these chapters are very minute, almost invisible when swimming in the sea, it is often necessary in collecting to drag the net about apparently at random, "skimming" as it is called the surface of the water, and then lightly washing off into the water of the collecting jars the small animals which although not seen have been caught on the meshes. An examination of the capture for identification must be made in a more favorable time and place than at night in the boat. The water into which the animals have been washed from the drag-net is commonly placed in glass dishes over a black background (tile preferred) and allowed to be-

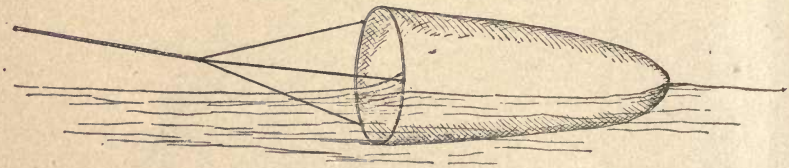
come quiet. It is well also to place the dish in such a way that direct light shines on one side in order to look through it from the other. The black ground and the light passing through the water make it possible to detect more easily sm al swimming larvæ. Commonly also, when the water in the dish is quiet, the minute embryos and larvæ come to the surface and can be seen and easily picked out with a pipette, from which they are transferred to a "live box," or watch crystal for study.

The present work goes no farther than the identification of the larvæ. Their method of treatment as objects of embryological research with reagents and with the microscope belongs to another chapter of marine zoölogy. Those who seek in these pages a faunal catalogue will find many omissions. I have tried to write an introduction to the fascinating study of the adult and larval stages of the lower animals which are found in our bays.

C. Collecting Surface Animals.

(with tow or dip-net.)

The animals which constitute the surface fauna are obtained by what is called a towing-net. The towing-net is a bag made of strong linen or bunting and is dragged



TOW-NET FOR ÆQUORIAL ORGANISMS.

through the water after the boat. The mouth of the net is kept open by a metallic ring to which the mouth of the net is fastened. The net should be about a foot deep, and

the diameter of the ring of wire possibly twenty inches. The wire should be large enough not to be bent under a considerable strain.

Three pieces of line about the size of cod-line and about two feet long are fastened at equal intervals in the ring. These are all joined at one end and attached to the towing-line. Enough of the towing-line should be let out to cause the net to work just below the surface. The length of the towing-line must be learned from experience.

The towing apparatus, thus rigged, is used in the following way: After the net is thrown over the stern of the boat, a moderate headway is given to the boat. The length of time the net must be dragged is regulated by the abundance of surface life. Care should be taken that the headway of the boat is not lost, as in such a case the animals are washed out of the net. To obtain life from zones below the surface the net can be weighted by a weight determined by the length of the tow-rope, the velocity of the boat and other circumstances. Care should be taken, if the direction of headway is changed, that the net is always kept distended in its original direction. When there is a coastward current under a bridge, the towing-line may be fastened to the bridge and the force of the current utilized to distend the net.

a. Freeing the net of its collections.

The net is hauled on board and the contents simply washed into a pail of pure water by turning the net wrong side out. An ordinary water bucket is a good collecting vessel. For detection of the specimens the best plan is to use glass vessels over a black ground. Mr. A. Agassiz uses flat glass pans over a table of black tiles. Allman recommends a white glazed earthenware pan such as is used in dairies for holding milk. If the bowl is placed in a deep

glass jar or finger bowl so that the light passes through it, small animals can be detected through the sides. Most of the small animals seek that side of the vessel on the surface turned to the light and one can easily find them there. Small glass finger-bowls in which larvæ can be raised, can be examined by holding them between the light and the eye. The animals may be picked out by pipettes or tubes. The water in which the animals are first placed, if crowded with life, soon becomes vitiated. When few animals are found they can be left in the pan in the same water in which they were captured. It is a good plan to add in such cases some pure water, and keep in the pan small genera of bright green algæ.

b. Collecting surface animals by observation in the water.

Although the dip and the drag-net yield the best results, it is often necessary to see the animals in their native habitat, in order to pick out what is wanted. The surface is often so crowded with Salpæ, for instance, that the net gets clogged with them, and a person in search of anything else cannot use the net to advantage.

If the sea is very smooth, very small animals can be detected by the eye from the boat. I have used a water-glass with advantage. The fishermen in Villa Franca, southern France, carry a bottle of oil in the boat and use oil to quiet the surface. A blackened plate of tin, lowered in the water, renders it possible to detect very small animals in the water above it. When once detected, it is not difficult to capture the animal with glass dishes or hand nets.

c. Places for collecting surface animals.

The best localities must be learned from observation. Tide eddies are favorable points, and the water in the vicinity of floating masses of seaweed is sometimes crowded

with life. The time of day seems not to matter but the tide is a great factor. At low tide we expect littoral, at high tide pelagic animals. At night conditions are favorable at about half-past eight when the sea appears calm. Calm weather is a desideratum, and a glassy calm is a very favorable opportunity.

In night-fishing an incandescent electric light may be hung at the mouth of the net to attract animals. The color of the phosphorescence corresponding to different animals must be learned by experience.

III. CŒLENTERATA.

The animals of this group have a great variety of external outlines, but several common anatomical likenesses. In their simplest form the bodies consist of a simple gelatinous bag, fixed to the ground or free-swimming. There is an opening called the mouth at one pole, while the whole cavity of the sac serves as a stomach or is in free communication with the exterior medium through the mouth-opening. In most of these animals the body cavity is continuous with the stomach. In many there is no body cavity except the stomach, a characteristic which has given the name of Cœlenterata to the group.

Rising higher than the simple sac, whose walls serve as the linings of a stomach and whose opening is a mouth, we pass to those where thread-like organs called tentacles, which serve to capture food, are placed in a ring about the mouth, and higher still to those where portions of the body walls are inflated into a bell-like structure for locomotion. Here we find added also sense capsules and complicated sucker-like oral appendages, the modifications in which will be more minutely described in considering the different genera. These organs generally take a radial arrange-

ment about the polar mouth opening. It was that radial symmetry which Cuvier first recognized and which led him to unite these animals with others in the group of Radiata.

The Cœlenterata include the Medusæ and Actiniæ. While these animals have much in common in their anatomical structure, their external resemblances are oftentimes very distant. Compare, for instance, the filmy, gelatinous body of the jelly-fish and the hard, stony coral as we see it in our museums. Yet the calcareous and other hard secretions of the body of the coral once removed, the soft parts which remain betray anatomical peculiarities of the stomach and body cavity already mentioned, and therefore close resemblances to jelly-fishes.

The Cœlenterata are divided into the Hydrozoa, Ctenophora and the Actinozoa. The two former groups, known as the jelly-fishes, are well represented by their larvæ in the surface waters of New England, while only a few forms of the latter occur, or come within the scope of this account. While the larvæ of some Actinozoa inhabit the surface waters, there are few genera in Narragansett Bay as compared with the other groups.

Class I. Hydrozoa and Ctenophora.

(*Jelly-fishes.*)

These animals have hyaline, gelatinous bodies; live solitary or united in colonies; bodies bell-shaped, tubular, mushroom-like, cup-shaped, or resembling a floating bag or disk. When bell-shaped, a fleshy protuberance of folded membrane hangs down from the under side and serves as the stomach. The centre of the body is occupied by a cavity out of which slender tubes or vessels radiate to the bell-margin. These vessels may be united by a circular tube about the periphery or may end blindly

near the rim. They sometimes pass directly from centre to rim, at other times subdivide, bifurcate and coalesce. Different tubes in the same bell may have a straight or a tortuous, or a marginal course. The movement of a nutritive fluid in the tubes can be seen through the bell-walls. Bell-cavity present or wanting. When present, it is sometimes partly closed at its entrance by a washer-like body called the velum.

The bell margin of the Hydrozoa is either entirely crenated, slightly notched or scalloped. Small, transparent cells, the sense capsules, otocysts, with enclosed calcareous grains called otoliths, are commonly present. The number and structure of these organs vary in different genera. In the Hydrozoa, when present they are placed around the bell margin and their number is from four to sixteen; in the Ctenophora there is, in the adult, a single polar sense capsule. The sense-capsules of the former group are partially covered on the upper side by a small, gelatinous lappet which is called the "hood." Jellyfishes which have a hood are called the "hooded-eyed"; those without, the "naked-eyed" Medusæ.

Small, thread-like bodies, called tentacles, varying in number and size, hang down singly or in clusters from the under side of the body at or near the bell-margin. In those genera (Ctenophora) which have a single polar sense capsule opposite the mouth, there are either two long tentacles with side branches with numerous smaller body filaments, or these structures may be wholly wanting.

These animals are generally small, transparent, phosphorescent in darkness when the water is agitated. Many are highly colored. Water forms the great mass of the body substance. Their larval forms are among the most abundant animals found on the surface of the ocean. The Hydrozoa are classified as follows:

Order I. Hydroida. Bell-shaped bodies, without flap

(hood) over the sense capsules and with or without marginal sense bodies; with bell-cavity, the entrance into which is partially closed by a velum.

Order II. Trachymedusæ. Bell-shaped, often disk-like bodies. Four or eight sense capsules with or without hood. Bell-cavity with velum.

Order III. Siphonophora. Tubular or bag-like bodies. Many individuals of different shape and function united in a colony. With or without bell-shape and gelatinous appendages. When present, these resemble those of Hydroida.

Order IV. Acraspeda. Disk-shaped bodies with four, eight or sixteen marginal sense-capsules. No bell-cavity. No velum.

Order V. Ctenophora. Single polar sense-capsule without hood. Locomotion by means of eight meridional rows of vibratile flappers on outside of body.

Order I. Hydroida (free).

A. Without sense capsules; sexual organs never free from the base of the proboscis.

I. Tubes four, unbranched.

No tentacles	Pennaria.
One tentacle	Hybocodon.
Two tentacles	Stomatoca.
	Dinematella.
Four tentacles	Sarsia.
	Dipurena.
	Ectopleura.
	Zanclea.
More than four single tentacles.	Turris.
	Dysmorphosa.
	Staurophora.
	Calicopsis.
	Modeeria.

Four clusters of tentacles . . Nemopsis.
Eight clusters of tentacles . . Lizzia.
II. Tubes four, branched . . . . Willia.
III. Tubes eight, unbranched . . Melicertum.
Mabella.

B. With sense capsules; sexual organs suspended from radial tubes.

I. Tubes four, unbranched.

a. Stomach without peduncle.

Tentacles numerous, without smaller basal "spurs."

Obelia.
Oceania.
Clytia.

Tentacles numerous, with basal "spurs."

Eucheilota.

b. Stomach with peduncle.

Tima.
Eutima.

II. Tubes numerous.

Zygodactyla.

A. I.

Pennaria. Bell ovate; tubes four, broad. Tentacles slight projections of the bell-margin at the junction of the radial and circular tubes.

P. gibbosa.[1]

Hybocodon. Bell globose, asymmetrical. Tubes four, slender. Single tentacle generally with a cluster of budding Medusæ at its base.

H. prolifer.

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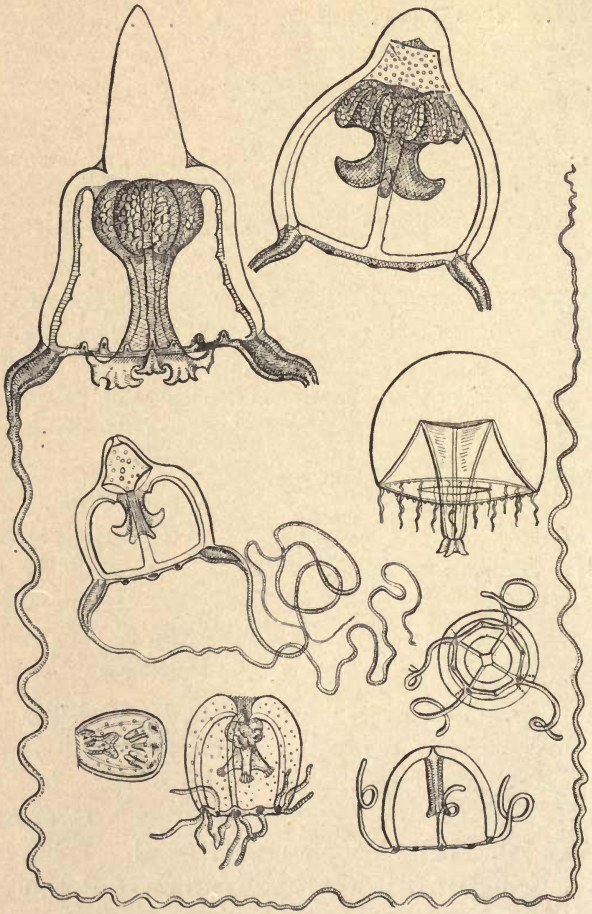
[1] Authorities for specific names are given in the index at the end of the paper.

Stomatoca. Bell oval, with tall, conical, apical projection. Tubes four, broad, often with jagged edges. Tenta-



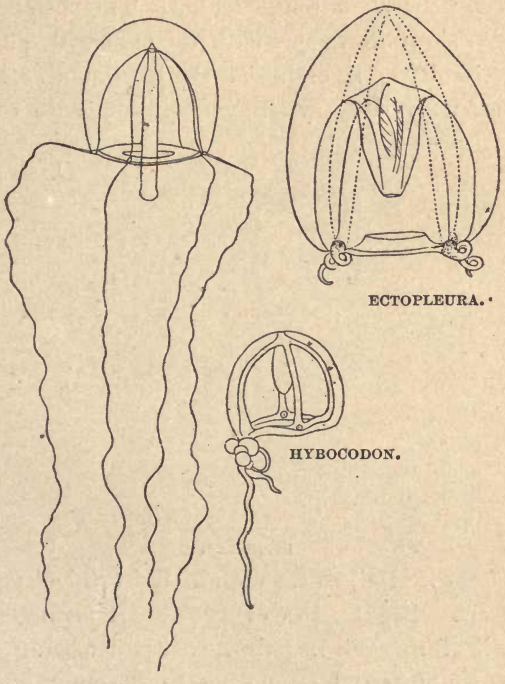
STOMATOCA. DINEMATELLA.
YOUNG DINEMATELLA. YOUNG TIMA.
YOUNG LIZZIA. CALICOPSIS.

cles two, opposite, long, very flexible. Their bases have a claret-red color. Proboscis trumpet-shaped, swollen near

the bell. Lips flange-like, extending barely outside the bell-opening.

S. apicata.

Dinematella. Bell ovate, with tall, conical, apical projection in which is found a cavity shaped like the frustrum of a cone, and which is in free communication with



ECTOPLEURA.

HYBOCODON.

SARSIA.

that of the proboscis. Tubes four, with jagged edges, broad. Tentacles two, opposite, long, flexible. On the bell-rim between the long tentacles are situated small tentacular processes with pigment spots. Proboscis large, swollen at base, light-cream color.

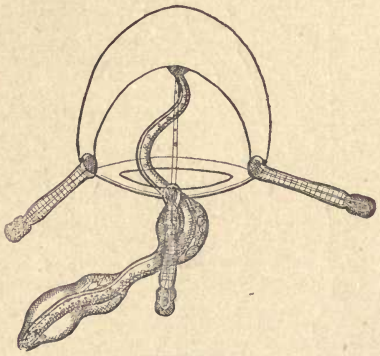
D. cavosa.

Sarsia.[1] Bell oval. Tubes four. Tentacles marginal, four, long, flexible, each with a single bright red pigment spot on under side of base at the extremities of the vessels. Proboscis very long, highly contractile; when expanded the extremity reaches far outside the entrance into the bell-cavity. Lips simple, ovaries inconspicuous.

S. mirabilis.

Dipurena. Bell half egg-shaped. Tubes slender, four. Four stiff, short tentacles with an enlarged club-shaped distal extremity. Eye-spot at the basal end. Proboscis very long, with large swellings crowded with ova in female. Lips simple.

D. strangulata.



DIPURENA.

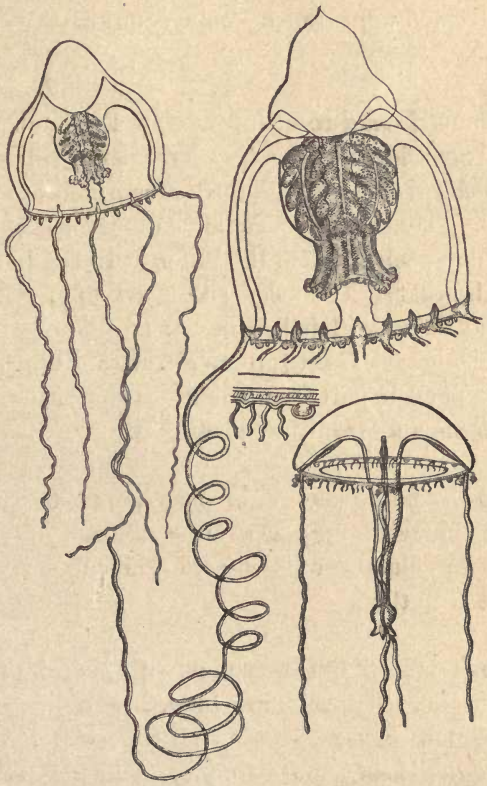
Ectopleura. Bell ovate with a slight apical projection. Tubes four. Eight rows of lasso-cells arranged on the outer wall of the bell in pairs, each pair arising from the base of a tentacle and extending to the apex of the bell. Tentacles four, generally coiled about their origin at the bell rim. Each tentacle in adult with clusters of lasso-cells at intervals in its length. Proboscis two-thirds the height of the bell cavity. Lips simple.

E. ochracea.

[1] Closely related to this is the free form of Hydrichthys which is attached to wall of fish *Seriola zonata*.

Zanclea. Bell oval, with slight apical prominence. Tubes four. Tentacles four, each with lateral branches formed of a small pedunculated cluster of cells. Proboscis extends to opening into the bell-cavity. Bell walls with cluster of lasso-cells above the origin of the tentacles from the margin.

Z. gemmosa.



YOUNG TURRIS. TURRIS.
OTOCYST OF EUTIMA. EUTIMA.

Turris. Bell mitre-shaped, with apical prominence. Tubes four. Tentacles numerous and of two kinds. The

longer bear eye-spots at their very origin from the bell-margin; the latter from a point a little above the rim. Proboscis large, swollen at the base. Mouth trumpet-shaped. Lips complicated.

T. episcopalis.

Dysmorphosa. Bell ovate with slight apical prominence. Tubes four. Tentacles numerous. Proboscis of medium size, with four spherical ovaries at base. Lips have a "frosted appearance" on account of the clusters of lasso-cells.

D. fulgurans.

This genus is said to occur in New England. See A. Agassiz, "Sea Side Studies." I have never collected it.

Staurophora. Bell disk-shaped, cream colored, with flexible walls. Tubes, four. Tentacle numerous, so crowded together that their bases at the union with the bell margin touch each other. Tentacles short, flexible, with single eye-spot at union with bell-rim. In addition to tentacles, small club-shaped bodies likewise arise from bell rim. Ovaries depend in part from the tubes in that half nearest the proboscis and from the proboscis.

S. laciniata.

Calicopsis. Bell ovate or globose. Tubes, four. Numerous short tentacles. Four ovaries at base of proboscis. Lips with four clusters of lasso-cells which impart a "frosted appearance" to them.

C. typa.

Modeeria. Bell mitre-shaped with apical projection, and thin walls. Tubes four, broad, with jagged edges. Tentacles numerous, flexible. Proboscis long, much swollen at the base. Lips simple.

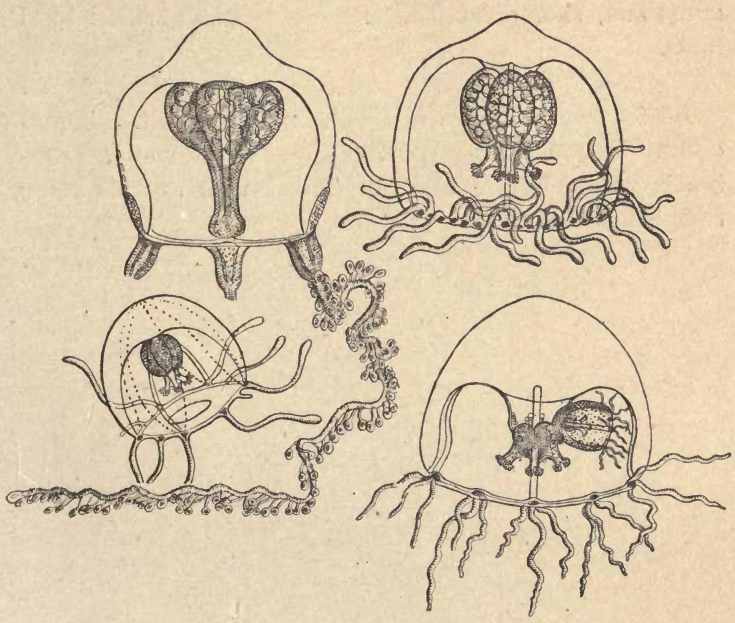
M. multitentacula.

Nemopsis. Bell oval. Tubes, four, broad. Tentacles in four clusters, each cluster situated at the union of radial

tubes and bell margin where there is a tentacular bulb with a row of pigment spots. Ovaries from tubes and proboscis. Proboscis short, with four oral dendritic tentacles.

N. Bachei.

Lizzia. Bell oval with apical projection and lower wall thin. Tubes, four. Eight clusters of tentacles from the



ZANCLEA. YOUNG CALYCOPSIS. MODEERIA. LIZZIA.

bell-rim. Four of these have five tentacles in each cluster and arise from the margin of the bell near the radial tubes and the remainder of three each alternate with these. Proboscis short, generally with budding young on its sides, with a quadrate mouth, each angle of which bears two clusters of lasso-cells.

L. octopunctata.

A. II.

Willia. Bell disk-like with small clusters of lasso-cells at intervals on the external walls. Tubes branched, four at origin from the proboscis.

W. ornata.

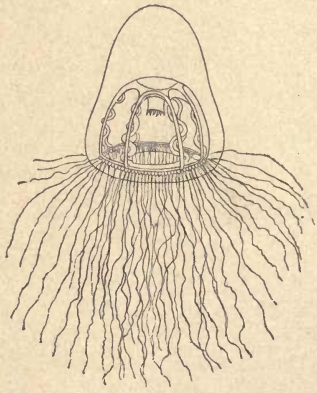
A. III.

Mabella. Bell globose. Tubes eight. Tentacles numerous, short, flexible. Proboscis small with lateral buds.

M. gracilis.

Melicertum. Bell oval, tall, mitre-shaped. Tubes eight. Tentacles numerous, long and very flexible. Proboscis with complicated lips. Tubes with ovaries along their whole length.

M. campanula.



MELICERTUM.

B. I, *a.*

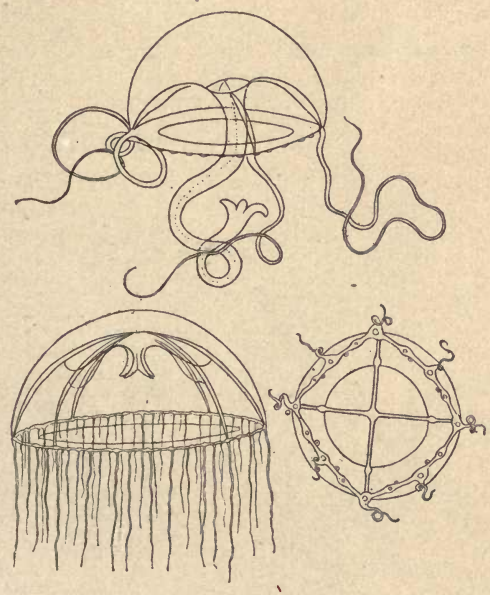
Obelia. Body disk-shaped, transparent, colorless. Sense-capsules with numerous otoliths, arranged at irregular intervals about the bell rim. Numerous rigid tentacles. Four tubes. Ovaries spherical, pendent from the tubes. The bell o ten reversed, and turned in such a

manner that the proboscis appears to arise from its convex side. Velum narrow.

O. gelatinosa.

Clytia. Bell disk-shaped, transparent, colorless. Tubes four. Tentacles numerous. Sense-capsules, eight. Tentacular bases thickly pigmented. Proboscis short, lips simple.

C. bicophora.

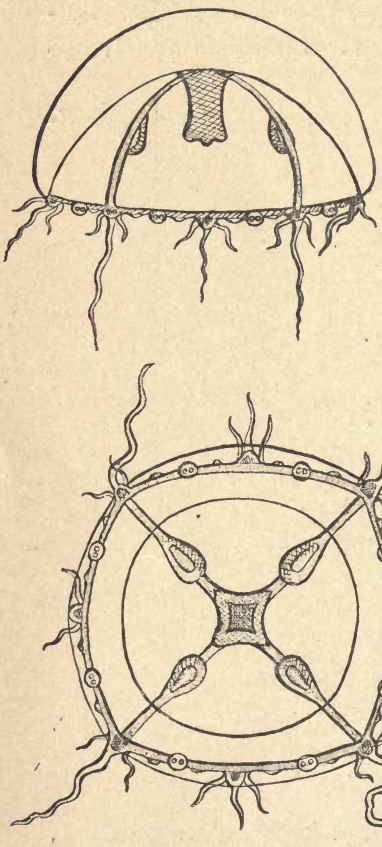


STAUROPHORA. LIRIOPE. CLYTIA.

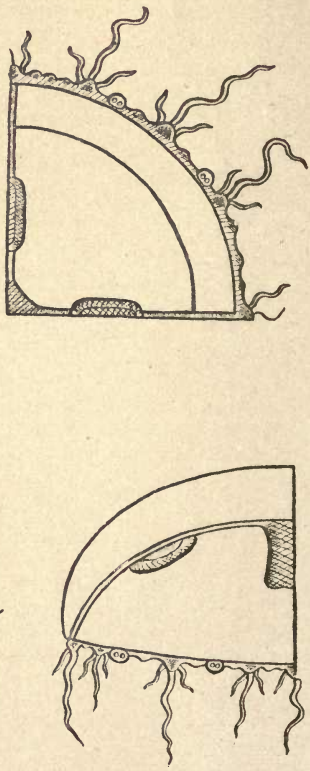
Oceania. Bell, very flexible, disk-shaped, transparent, and moves with a languid motion. Four tubes with elongated ovaries. Tentacles numerous, thread-like, flexible. Proboscis short. Ovaries found on the peripheral two-thirds of the radial tubes.

O. languida.

Eucheilota. Bell disk-shaped, flexible, transparent. Tubes four. Ovaries spherical, hanging from the tubes. Sense-capsules, eight. Tentacles of two kinds, eight long,



YOUNG EUCHEILOTA.



EUCHEILOTA.

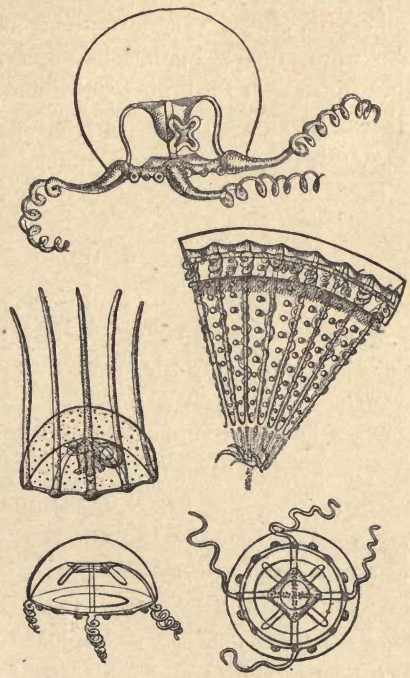
and sixteen small; shorter called spurs. Each long tentacle has a pair of spurs. Tentacular bulbs pigmented.

E. ventricularis.

B. I, *b.*

Tima. Bell hemispherical with thick walls. Tubes four. Tentacles, numerous, long, flexible. Ovaries ribbon-shaped on the tubes. Sense-bodies, numerous. Stomach mounted on a transparent peduncle. Lips, four-parted, margin with clusters of lasso-cells.

T. Bairdii.



SPHÆRULA.

MABELLA. SECTOR OF ZYGODACTYLA.

YOUNG ZYGODACTYLA.

Eutima. Bell oval, with thin walls, flexible. Tubes four. Tentacles of two kinds; four long at extremity of the tubes; pairs of small tentacles at intervals about the bell margin. These latter also accompany the long tentacles and may be called spurs. Stomach mounted on a slender

peduncle which extends far outside the bell opening. Lips quadrate. Ovaries ribbon-like on tubes and base of peduncle.

E. gracilis.

B. II.

Zygodactyla. Bell disk-shaped, cream colored, also pinkish. Tubes numerous with ribbon-shaped ovaries. Tentacles numerous, short, very flexible, generally coiled. Sense-capsules numerous. Proboscis finger-like folds of a delicate membrane which seldom closes forming the mouth opening. Rows of small tubercles on the walls of the bell-cavity between the chymiferous tubes.

Z. Grœnlandica.

Free-swimming larvæ.

A. I.

Pennaria gibbosa. The young Pennaria closely resembles the adult. This stage is rarely found free-swimming on the surface, although if a colony of the hydroids be kept in a glass jar for a short time, the buds if mature easily drop off and swim away.

Hybocodon prolifer. The larvæ of this medusa can best be studied by a comparison of the different medusa buds found on the tentacular bulb of the adult. Free forms are extremely rare and after they attain the stage when they separate, their resemblances to the adult are very close.

Stomatoca apicata. Larva like adult with tall bell which, however, is destitute of apical prominence. Tubes four, broad. Tentacles, two, opposite, long, very flexible. No little tentacular projections on the bell-rim between the tentacles. Proboscis shorter than in adult, extending to the bell opening.

Dinematella cavosa. Larva without apical projection on bell apex. Cavity at base of the proboscis small, want-

ing. Small finger-like projections on the bell margin wanting. Color of larva like that of adult.

Sarsia mirabilis. Larva resembles adult.

Dipurena strangulata. Larva not studied.

Ectopleura ochracea. Larva like adult.

Zanclea gemmosa. Bell ovate without apical prominence. Tubes four. Tentacles two, each with numerous lateral branches. In some young forms the two additional budding tentacles are seen. Bell with clusters of thread cells as in adult.

Turris episcopalis. Larva with characters of adult.

Dysmorphosa fulgurans. Larva not observed.

Staurophora laciniata. Larva like adult.

Calicopsis typa. Larva like adult.

Modeeria multitentaculata. Larva not observed.

Nemopsis Bachei. Larva has few tentacles in each cluster. Dendritic labial branches less complicated.

Lizzia octopunctata. Larval forms of Lizzia in all stages of growth found on the sides of the proboscis. The young can be studied from these buds. 1. Youngest bud has single tentacle at each end of the radial tubes and single intermediary tentacle. 2. The next oldest has a cluster of three tentacles at end of each tube and three intermediary in cluster. 3. Oldest with five tentacles at the end of each tube with three in intermediary clusters. The stages 2 and 3 are free, and have rudiments of the second generation of buds on the outside of proboscis. The very immature buds also found in younger stages have half formed probosces.

A. II.

Willia ornata. Larva with four tentacles one at each end of the four unbranched tubes. Alternating with these on the bell walls a small cluster of nematocysts. Apical tube visible.

A. III.

Mabella gracilis. Larva not observed.

Melicertum campanula. Larva like the adult.

B. I, *a.*

Obelia diaphana. Larva like adult.

Clytia bicophora. Larva in youngest form with two tentacles opposite each other and eight otocysts.

Oceania languida. Larva in youngest form with two opposite tentacles, four otocysts. Proboscis small, inconspicuous.

Eucheilota ventricularis. Larva like adult.

B. I, *b.*

Tima Bairdii. Larva like adult. Tentacles short, numerous. Proboscis small. Otocysts like adult.

Eutima gracilis. Larva not observed.

B. II.

Zygodactyla Grœnlandica. Larva in youngest form found with four tubes, four tentacles. Numerous otocysts. Next oldest larva has four complete tubes and four additional tubes extending half way from junction of proboscis and bell margin.

Order I. Hydroida (attached).

Many of the jelly-fishes originate as buds from an attached zoöphyte known as a hydroid. To become familiar with the different forms of the young of the Hydrozoa, it is necessary to be able to identify these animals.

The fixed hydroids are algæ-like organisms, simple or branching, with soft or hard axis. They are solitary or social, and give rise to medusæ by budding or by processes resembling fission.

Athecata.[1]

Without thecæ for hydranth or sexual bodies.

A. Forming calcareous encrustations. . Hydractinia.

B. Erect, plant-like, not parasitic.

I. Solitary.

a. Tentacles capitate, scattered over the body . . . . . Acaulis.

b. Tentacles filiform, in two circles. Corymorpha.

II. Associated.

a. Tentacles of one kind.

Tentacles capitate in single whorl. Clavatella.

Tentacles filiform.

a. Two separate rings of tentacles with free medusæ. Ectopleura.

b. Two tentacular circles without medusæ . . . Tubularia.

c. Scattered, with hydranth on branch of stem . . . . Tubiclava.

b. Tentacles in single verticil, without bosses.

Polyps sessile . . . Podocoryne.

Polyps on stem, with trumpet-shaped proboscis . . . . Eudendrium.

Hydranth without covering, with conical proboscis. Gonophores on cœnosarc.

a. Arborescent . . Bougainvillia.

b. Small, simple habit. Perigonemus.

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[1] Thecæ, or cups surrounding the hydranth or stomach with a crown of tentacles about a mouth. Athecata; ἀ, θῆκα, without a cup. Thecaphora; θῆκα-φέρω, cup bearing.

b. Tentacles of two kinds.

Upper, capitate; lower, rigid in single verticils . . . . . Cladonema.

Upper, capitate; lower, filiform in several verticils . . . Stauridium.

c. Tentacles in several whorls.

Capitate without free medusæ.

Coryne.

Capitate with free medusæ.

Syncoryne.

C. Parasitic on *Seriola zonata* (osseous fish).

Hydrichthys.

No tentacles, two kinds of individuals. Hydroid reduced to a botryoidal cluster of medusæ.

Thecaphora.

Hydroids with hydranth and sexual bodies enclosed in a cup.

A. Calycles[1] erect and free, hydranths retractile.

I. Calycles supported on a short process from the stem; hydranths partially retractile.

With tentacular organs over the cœnosarc.

Ophiodes.

Without tentacular organs over the cœnosarc.

Halecium.

II. Calycles bell-shaped.

a. Operculated . . . . . Lovenella.

b. Non-operculated.

Clytia.

Obelia.

Campanularia.

Thaumantias.

Gonothyræa.

[1]Cup-like structures, hydrothecæ, in which the hydranths are protected.

III. Calycles not bell-shaped.

a. Calycles conical, long . Campanulina.

b. Calycles with conical operculum, constricted at base; pedicellate. Calycella.

c. Sessile; not constricted at the base. Cuspidella.

d. Calycles without conical operculum, scattered . . . . . Lafœa.

B. Calycles adnate, disposed along the stem and branches.

I. Without nematophores.[1]

a. Calycles cylindrical and disposed on all sides of stem . . . . . Salacia.

b. Calycles on creeping stem (not erect). Filellum.

c. Calycles in two series.

1. Alternate, with operculum. Sertularella.

2. Without operculum.

a. Gonothecæ with cleft margin and internal marsupium. Diphasia.

b. Orifice of gonotheca, plane; no internal marsupium.

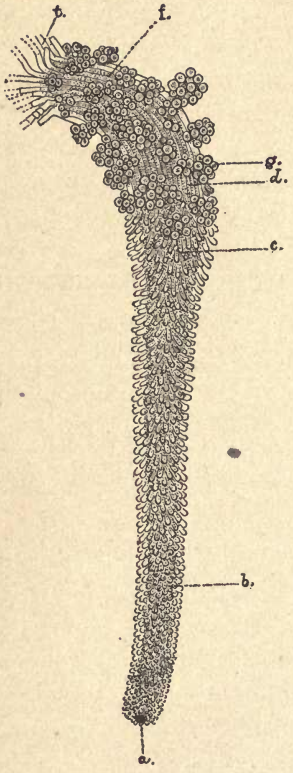
With verticillate branches. Sertularia.

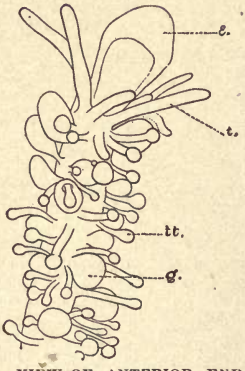
Without verticillate branches. Antennularia.

1. With mesial nematophore attached to part of calycle. Aglaophenia.

2. Without mesial nematophore. Plumularia.

[1]Small cup-shaped structure resembling small calycles in which a protoplasmic thread-like body is found, and from the inner base of which it arises.





VIEW OF ANTERIOR END OF ACAULIS, SHOWING TEMPORARY TENTACLES *tt*.

ADULT ACAULIS. *a*, TERMINAL OPENING OF THE BODY—THE INTERIOR OF THIS BODY IS "DARK REDDISH PURPLE;" *b*, CENTRAL, PURPLE-COLORED BODY WALL; *c*, SMALL PAPILLÆ—THESE, AS WELL AS THE EXTERNAL BODY WALL, ARE LIGHT PINK; *d*, RIDGES OR FOLDS IN THE EXTERNAL WALLS OF THE BODY, OF A "WHITE COLOR;" *e*, TERMINAL CONTINUATION (UNATTACHED) OF THE BODY OF THE YOUNG ACAULIS; *g*, GONOPHORES—THE INTERIOR OF THESE CLUSTERS IS DARK PURPLE, THE EXTERIOR, WHITE GRANULAR; *t*, PERMANENT TENTACLES—"SUCTORIAL TENTACLES;" *tt*, TEMPORARY TENTACLES.

A.

Hydractinia. Clavate sessile filiform tentacles from a conical proboscis from the cœnosarc. Naked polypary. Some polypites are partially developed and bear spherical clusters of thread cells. No medusæ. Found on shell inhabited by Eupagurus, or on floating wood, spiles, etc.

H. echinata.

B.

Acaulis. Solitary, cylindrical, terminated above in a conical proboscis. Adherent. Tentacles scattered, small over whole body. Gonophores clustered about base.

A. primarius.

Corymorpha. Polypite solitary, in delicate sheath. Two sets of filiform tentacles. Oral tentacles in several verticils placed close together. Prominent proboscis. Roots attached in sand.

C. nutans.

Ectopleura. Stem delicate, slightly branched. Twenty-four oral; thirty lower tentacles. Medusæ developed between the two series.

E. ochracea.

B. II. *b.*

Tubularia. Stem simple and branched, rooted by a filiform stolon with inverted polypary. Filiform tentacles in two whorls. Gonophores on peduncles between two whorls of tentacles. Young has an actinula form.

T. indivisa.

Clava. Clavate, tentacles smooth, sheathed in chitinous polypary. Buds borne in clusters. No medusæ. On *Fucus.*

C. leptostyla.

Tubiclava. Erect stem with branches and creeping

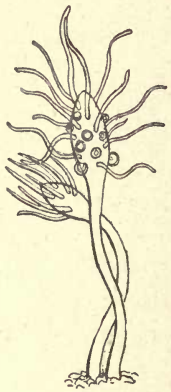
stolon. Sheathed in chitinous polypary. Buds in clusters below lower tentacles. No medusæ.

T. cornucopiæ.

Podocoryne. Cœnosarc thick network; polypary forms a continuous crust which forms a small cup-like invest-

TUBULARIA.

CORYMORPHA.



CLAVA.

ment round the base of polypites. Single verticil of tentacles. Gonophores borne below the tentacles. Free medusæ. Gonosome bell-shaped. Short manubrium with oral tufts of thread cells. *P. carnea.*

Eudendrium. Stem branched with creeping stolon. Chitinous perisarc. Hydranths borne at the end of branches, vase-shaped. Single verticil of filiform tentacula. Gonophores from polypites below the tentacles or from the stem with fixed sporosacs.

E. dispar.
ramosum.
rameum.
cingulatum.
capillare.
tenue.

Perigonemus. Cœnosarc chitinous. Stem branching with thread-like stolon. Single verticil of tentacles; gonophores developed from cœnosarc.

Medusa, *Stomatoca.*

Bougainvillia. Stem branched, rooted by filiform stolon. Cœnosarc with chitinous covering. Single circle of tentacles round base of conical proboscis.

Medusa, *Nemopsis* and *Bougainvillia.*

N. Bachei.

B. superciliaris.

Cladonema. Stem simple, slightly branched. Four capitate, tuberculate tentacles, from false tentacles which are stiff, and rounded at the extremities.

C. radiatum.

Stauridium. Creeping stolons, stem simple. Four whorls of cruciformly arranged tentacles, which are rigid, extending at right angle to the body.

Syncoryne. Stem simple or branched, rooted stolon wholy covered in tube. Medusa is Sarsia.

S. mirabilis.

C.

Hydrichthys. Parasitic on body walls of a fish. No tentacles; no terminal mouth opening. Sexual clusters, botryoidal.

H. mirus.

Thecaphora.

A.

Ophiodes. Stem, branching, base enclosed in cup; stolon root-like; non-retractile hydranths which are divided by a constriction into two regions. Webbed tentacles in a single verticil.

O. mirabilis.

Halecium. Plant-like, branched, rooted by creeping stolon. Hydrothecæ biserial, tubular, bell-shaped, subsessile, jointed to short lateral process. Hydranth partially retractile. Fixed sporosacs.

H. gracile.

Lovenella. Stem simple, branched, thread-like stolon. Hydrotheca turbinate, elongate, crowned with a conical operculum.

L. gracilis.

Clytia. Stem simple, branched slightly. Creeping stolon. Hydrothecæ bell-shaped. No operculum. Hydranths with large trumpet-shaped proboscis. Medusæ on stolon and stem.

Medusa, *Clytia.*

C. Johnstoni.

Obelia. Stem branching, plant-like, creeping stolon. Bell-shaped. No operculum. Gonothecæ on stem and branches.

O. gelatinosa.
commisuralis.

Campanularia. Stem simple, branched, filiform stolon. Hydrothecæ bell-shaped. No operculum. Hyaline. Hydranths with cup-shaped proboscis.

Gonophores fixed sporosacs, which mature in the capsule.

C. caliculata.

Thaumantias. Stem simple or branched, rooted to thread-like stolon. Calycles campanulate, with funnel-shaped proboscis.

Gonothyræa. Stem erect branching, thread-like stolon. Hydrothecæ bell-shaped, transparent. Proboscis prominent, contractile.

G. tenuis.

Campanulina. Stem slender, annulated. Calycles thin,

membranous, pointed, produced. Hydranths with webbed tentacles.

C. acuminata.

Leptoscyphus. Stem simple or branching, attached by a thread-like stolon. Hydrothecæ with operculum composed of convergent segments. Hydranths cylindrical with medusiform zoöids.

Medusa, *Lizzia grata?*

Lafœa. Stem simple, creeping tubular fibre, or erect and composed of many aggregated tubes rooted by a filiform stolon. Hydrothecæ tubular, sessile or with a short pedicel. No operculum. Hydranths cylindrical with conical proboscis.

L. robusta.

Calycella. Stem a creeping tubular fibre, erect, compound branched, rooted by a filiform stolon. Hydrothecæ tubular with an operculum formed of convergent segments or a plaited membrane. Hydranths cylindrical with conical proboscis. Fixed sporosacs.[1]

C. humilis.

B

Salacia (*Grammaria* Stimpson). Stem erect, composed of aggregate tubes, branching rooted. Hydrothecæ cylindrical, sessile, no operculum, adnate for part of length. Disposed on all sides of the stem in regular and equidistant longitudinal series.

S. robusta.

Filellum. Stem creeping, filiform, reticulate, immersed in chitinous crust. Hydrothecæ tubular, decumbent, adherent. No operculum, irregularly arranged along the stem to which they are attached by short stalk.

Sertularella. Plant-like. Stem branching, jointed,

[1] Sacs in which the spores are contained; gonosac, sac containing the male sexual elements.

rooted by a creeping stolon. Hydrothecæ biserial, alternate, orifice toothed. Operculum of several pieces.

S. polyzonias.

Diphasia. Plant-like. Stem branching, jointed, rooted by a creeping stolon. Hydrothecæ opposite, pair on each internode. Valve-like operculum. Gonothecæ scattered, different in male and female.

D. fallax.

Sertularia (*Dynamena*). Plant-like; stem branching, jointed, rooted by creeping stolon. Hydrothecæ biserial, opposite or alternate. No operculum. Gonothecæ scattered.

S. pumila.

Antennularia. Plant-like. Stems simple or branching, with verticillate branchlets and rooted by a mass of fibres Hydrothecæ cup-shaped. Nematophores bithalmic on stem.

A. sp.?

Plumularia. Hydrothecæ sessile, unilateral. With nematophores or minute cups which contain an extensile offshoot from the cœnosarc, with or without nematocysts. Gonozooids fixed.

P. Verrillii.

Aglaophenia. Plumose, simple or branched, rooted. Hydrothecæ cup-formed. Nematophores on the Hydrothecæ. Gonothecæ in the form of corbulæ.

A. arborea.

Order II. Trachymedusæ.

Sense-bodies with a hood. With a bell-cavity and velum. Medusæ transparent, of small size resembling in many particulars the Hydroida. Body disk-like, spherical, conical; colorless. Walls sometimes rigid, sometimes flexible. Marginal tentacles stiff, sometimes easily decid-

uous in single row. Often obscurely "hooded eyed." Proboscis and radial tubes generally present, often absent.

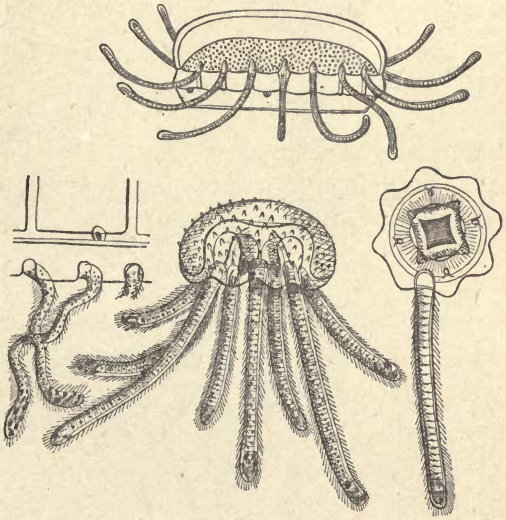
A. Without proboscis . . . . . Cunina.

B. With proboscis.

I. Body-walls rigid . . . . Trachynema.

II. Body-walls flexible . . . . . Liriope.

Cunina. Body disk-shaped, inflexible, destitute of radial tubes. Tentacles rigid, arise from sides of the body



CUNINA.

SECTION OF THE BELL RIM OF TRACHYNEMA.

YOUNG TRACHYNEMA.

not from disk margin. Velum muscular, forming the lower floor of stomach-cavity.

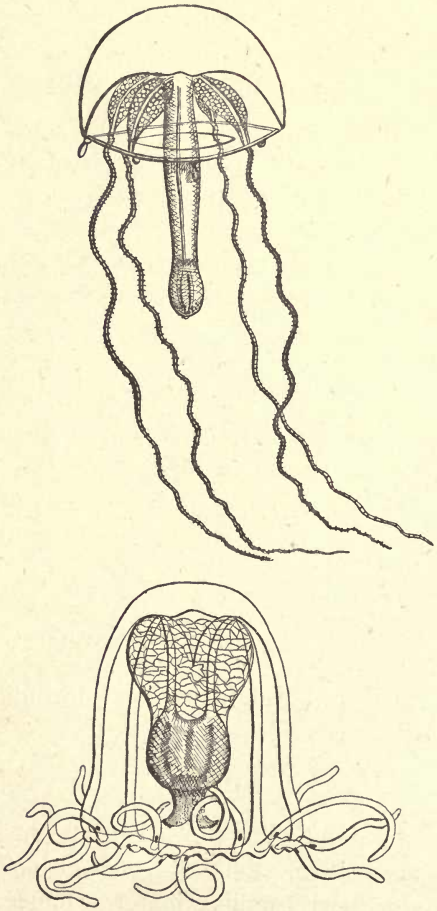
C. discoides.

B. I.

Trachynema. Umbrella mitre-shaped with rigid walls, with quick spasmodic movements in propulsion. Onward motion caused in part by vibration of velum. Tentacles numerous with rigid bases. Eight radial tubes, generally

stump-like on account of deciduous extremities. Eight bright-red sense-capsules without covering lappets or "hoods." Proboscis pedunculated. Lips quadrate with numerous lasso-cells. Eight sausage-like ovaries hanging in bell-cavity from radial tubes.

T. digitalis.



LIRIOPE.
MODEERIA (TURRITOPSIS).

B. II.

Liriope. Body mushroom-shaped with flexible walls. Tentacles long, flexible, four in number. Four radial tubes. Proboscis pedunculated. Otocysts naked, with accompanying tentacular appendages. Ovaries on radial tubes, heart-shaped, slightly pendent from the inner walls of the bell.

L. scutigera.

Free-swimming larvæ.

The larval forms of the Trachymedusæ are very rare in Narragansett Bay. The youngest Trachynema which was found has a disk-shaped body, very obscure proboscis and eight tentacles alternating with eight otocysts. The surface of the body and the tentacles are ciliated.

C. discoides is a very rare medusa in New England waters and only two forms have been found; one with eleven and the other with fourteen tentacles.

Order III. Siphonophora.

Polymorphic medusæ generally with a tubular-formed body. With or without a float. With flask-shaped stomachs (polypites), from which depend long, contractile tentacles. Many have swimming-bells (nectocalyces), covering-scales and characteristic flask-like bodies called tasters. Colonies monœcious or dicœcious. Reproduction by ova and by budding.

A.	With a float	Physophoræ.
	I. With an axis	Agalmoides.
		Nanomia.
	II. Without an axis	Physalia.
B.	Without a float	Calycophoræ.

A. I.

Agalmoides. Body tubular, with colored axis, size of

a knitting-needle; float small. Nectocalyces arranged in two opposite rows on the third of the axis below the float, called the nectostem. Covering-scales flat, quadrangular in shape. Stomachs or polypites, arranged at intervals on lower two-thirds of the axis called polypstem. Tentacles long, contractile, dotted with lateral appendages (tentacular knobs). Each tentacular knob with pedicel; coiled cork-screw part (sacculus) covered by an involucrum; two terminal filaments and spherical vesicle. Ova and spermatozoa on the same individual or colony.

A. elegans.

Nanomia. Body tubular with colored axis; float small. Nectocalyces arranged in two rows on the third of axis. Covering-scales flat, quadrangular. Stomachs or polypites, on two-thirds the axis. Tentacles long, contractile, when retracted thrown into festoons. Tentacular knobs with sacculus, involucrum and single terminal filament. Ova and spermatozoa in respective bells on same colony.

N. cara.

A. II.

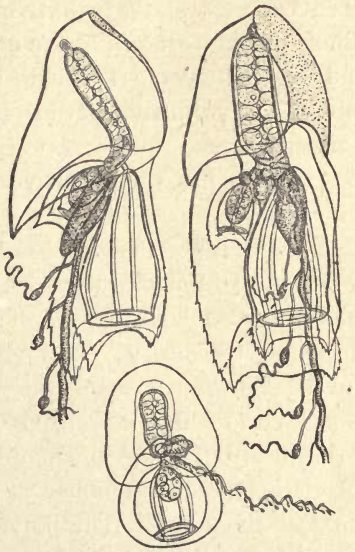
Physalia. Body bag-shaped, floating on the surface of the water, with appendages hanging down in the water on the lower side. Float pointed at one end with raised chambered crest on the upper side. Tentacles very long, contractile, armed at intervals with reniform thickenings of lasso-cells. Polypites numerous. Sexual bodies in the form of buds on a branching axis.

P. Arethusa.

Diphyes. Two small gelatinous nectocalyces placed end to end with openings into cavities pointing in same direction. Anterior conical, with four radial tubes of unequal length and single blind tube called the somatocyst in the bell walls on one side. Posterior bell with radial tubes of the same length, no somatocyst. Axis long, flexible,

with clusters of individuals at intervals. Sexual organs connected with these clusters.

D. formosa.



EUDOXIA LESSONII.
DIPLOPHYSA INERMIS.

Free-swimming larvæ.

Agalmoides elegans. The egg is dropped from the bells in the cluster of female sexual bodies and goes through its segmentation in the water.

There are three larval stages in the progress of the development which are called:

1. Primitive larva.
2. Athorybia stage.
3. Physophora stage.

All of these are found free-swimming in surface fishing; the first is rare, the second and third are taken almost

every summer in Narragansett Bay. The Physophora larva is the most common.

The primitive larva consists of a primitive polypite formed directly from the egg or budded from its side, a helmet-shaped covering-scale, the primitive covering-scale, or hydrophyllium, through which pass an unbranchal primitive canal and an embryonic tentacle with transitory tentacular knobs. The primitive larva swims at moderate depths in the aquarium.

The Athorybia stage has no primitive covering-scale, but a circle of serrated, provisional covering-scales, a transitory tentacle with tentacular knobs, a float, polypite, taster, and is destitute of nectocalyces. The axis from which the circle of serrated covering-scales in this larva arises is also probably transitory. The Athorybia stage is generally found free on the surface of the water.

The Physophora larva resembles closely the adult with the exception that it still retains the embryonic tentacle with its characteristic tentacular-knobs. Float and nectocalyces like those of the adult. The portion of the stem below the nectocalyces, called the polypstem, is enlarged at its very extremity somewhat as in the genus Physophora. Covering-scales like those of the adult are present, and the permanent tentacle with the knob characteristic of the adult coëxist with the embryonic. Both depend from the extremity of the stem opposite the float. A small cluster of immature buds just below the lower pair of nectocalyces are undeveloped polypites and tasters.

Physalia. The youngest Physalia has a float and polypite with a single tentacle. Of the very young Physalia little is known. There are no known provisional organs. The float is small, spherical or slightly oval in form.

The young stages of Diphyes have never been observed in Narragansett Bay, yet certain forms called the Diphy-

zoöids may be described here. A Diphyzoöid is a fragment of a Calycophore which has an independent life. Two forms of Diphyzoöids have been found in Narragansett Bay. They are known as *Eudoxia Lessonii* and *Diplophysa inermis.*

Diplophysa inermis. This species is the diphyzoöid of *Monophyes gracilis*, and in the cycle of development we have, according to Chun, stages corresponding with the following genera:

1. Monophyes.
2. Muggiæa.
3. Diplophysa.

Monophyes has not yet been recorded from New England. Muggiæa has been taken once or twice.

Order IV. Acraspeda.

Body or umbrella, disk-shaped. Sense bodies with a hood. Velum obscure. Without a bell cavity. Body gelatinous, flexible, convex above, generally colored. From centre of under surface hang long projections, or curtain-like folds, which enclose a stomach. Filaments (tentacles) arranged in bundles or simple rows around or near the disk margin. Sense bodies alternating with the tentacles on the bell rim, covered with "hoods."

A. Eight sense-bodies on umbrella margin.

Cyanea.
Aurelia.
Dactylometra.

B. Sixteen sense-bodies on umbrella margin.

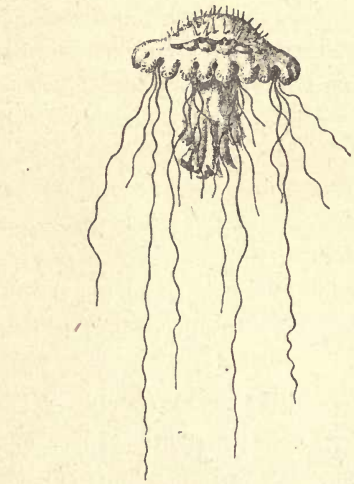
Callinema.

A. I.

I. Body red; mouth parts in folds; tentacles long, conspicuous, in clusters . . . . . Cyanea.

A. II.

II. Body white; mouth parts four tentacular bodies; tentacles short, inconspicuous . . . . . Aurelia.



YOUNG CYANEA.
AURELIA.

A. III.

III. Body pink; mouth parts in four long tentacular bodies; tentacles long, in series . . . Dactylometra.

A.

Cyanea. Umbrella depressed with scalloped edges in which lie eight sense bodies, alternating with eight bundles of tentacles. Lips formed of curtain-like folds with

many ruffles. Chymiferous tubes dendritic. Color red and blue. Body very large.

C. arctica.

Aurelia. Umbrella disk-shaped with a single row of marginal tentacles. Eight hooded otocysts. Lips in the form of four fringed arms. Chymiferous tubes branched, not dendritic. Color cream or white. Body large size.

A. flavidula.

Dactylometra. Flexible umbrella, globular, discoid, with many marginal tentacles and incised edges. Lips in form of four long projecting tentacle-like appendages. Color pinkish; tentacles red. Tubes of body unbranched. No peripheral vessel.

D. quinquecirra.

B.

Callinema. Umbrella flat, thick with apical protuberance. Tubes radial, anastomosing in sixteen segments. Circular vessel with radial extensions. Sixteen sense lappets. Tentacles long, numerous, arising from circular vessel. Lips in curtain-like frills.

C. ornata.

Free-swimming larvæ.

The only free-swimming larvæ of Acraspeda yet described from New England are called the Ephyræ. Although other genera occur I have found only this stage of the two above-mentioned genera. The ova are borne in the folds of the mouth and their development into free planulæ can be easily traced into the sessile stages, Scyphistoma[1] and Strobila, descriptions of which do not come in the province of this work. The youngest free larva

[1]Lucernaria, which is closely allied to Scyphistoma, has cup-shaped, very contractile body with peduncle and is found attached to Zostera or some similar foreign object. Tentacles small in clusters of tuft-like bodies. Color brown or light green.

between the Strobila and adult is called the Ephyra. The Ephyræ of Cyanea and Aurelia closely resemble each other; that of Cyanea is, however, a little larger than that of Aurelia and has a brown or reddish color. Both have a flat, disk-shaped body, deeply emarginated by sixteen incisions of two depths; in the more shallow of which the otocysts are placed, while a single tentacle is found as a mere stump in the deeper. The lips are very simple and without folds. In vibrations of the umbrella the marginal lappets are commonly raised above the aboral region of the bell and then brought suddenly down below the mouth.

A larval stage of Cyanea older than the Ephyra, which approaches in many particulars the form of the adult, is well marked on account of the great development of small filaments placed at intervals over the aboral region of the bell.

The larval stages of Callinema and Dactylometra are not known.

Order V. Ctenophora.

Free-swimming, gelatinous animals with spherical, thimble-shaped or ovate forms. The external walls of the body crossed by eight meridional rows of paddle-like flappers. With or without tentacles. Single, large, compound otocyst at one pole. Chymiferous tubes radially arranged. Without proboscis.

A. Ctenophora without tentacles (Nuda) . Beroë.

B. Ctenophora with tentacles (Tentaculata).

I. Body spherical, without lateral lobes. Rows of flappers of same length. Pleurobrachia.

II. Body with large lateral lobes. Rows of flappers unequal in length. Mnemiopsis.

A. Nuda.

Beroë (Müller). Body ovate, hat-shaped, with pinkish color. No tentacles, no body lobes. Large central body

cavity. Chymiferous tubes anastomosing, with many lateral branches.

B. roseola.

B. II.

Pleurobrachia. Body spherical, transparent, colorless, of relative hard consistency. Meridional rows of flappers of equal length extending direct from the sense to the oral pole. Tentacles very long with lateral branches of crimson color, capable of being retracted into a chamber on each side of body.

P. rhododactyla.

Mnemiopsis.[1] Body transparent, compressed laterally and with two prominent lobes. Body colorless, with walls flexible. Tentacles short. Rows of locomotor flappers of unequal length. Four ear-like, ciliate (?) appendages ("auricles") near the mouth.

M. Leidyi.

Free-swimming larvæ.

The larvæ of the Ctenophora are among the most common of all the medusæ found in surface-fishing. The eggs sometimes occur in great numbers in the collecting jars where any of the different genera have been allowed to remain for a short time. They are sometimes found single, sometimes in strings. Ova are small when single as in Mnemiopsis and others, but can be observed with the unaided eye. These little transparent globes enclose an egg, the growth of which can easily be followed through early stages of segmentation. The larvæ of the Ctenophora, after leaving the egg sac, are difficult to refer to

[1] *Bolina alata* is closely allied to this genus.

their respective genera. Those of Beroë never have tentacles. Of the tentaculated genera Pleurobrachia and Mnemiopsis, the former has long tentacles which never diminish in size with age and is destitute of lateral lobes, while the latter has widespreading lobes which increase very greatly in size with advancing growth and the tentacles become smaller and smaller in the progressive growth. The adult has rudimentary tentacles. The young of the Ctenophora are never sessile, with no intermediate asexual form; consequently the development is said to be direct.

Class II. Actinozoa.

Cœlenterates attached or free. Stomach bag-like, with linear mouth opening into body cavity. Radial septa in body cavity. Internal sexual bodies. Without medusiform gonophores, solitary or colonial. Body soft with mural spicules, calcareous septa horny, flinty axis. Often shrub-like, branching.

Actinoida.

Tentacles twelve or numerous, hollow, sometimes perforate, rarely branched. Bodies soft. Skeleton when present calcareous. Spicules absent in body.

A. Bodies soft, generally solitary, attached or free. Tentacles numerous . . . . . Actiniaria.

I. Adherent.

Disk lobed . . Actinoloba (Metridium).

Disk not lobed. Body covered with warts. Bunodes.

Cœnosarc developed. Colonial, two circles of tentacles . . Polythoa (Zoanthus).

Tentacles, many circles. Solitary. Tealia (Rhodactinia, Urticina).

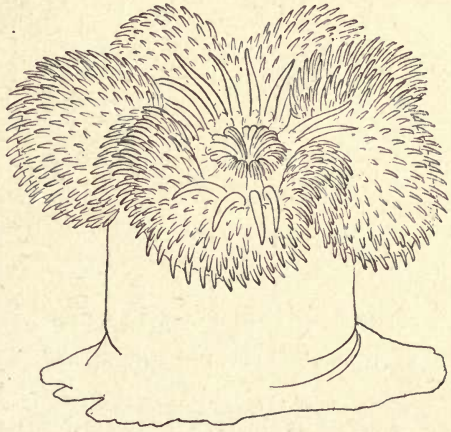
II. Communal and adherent.

a. In branching colonies . . Lophohelia.

b. In calcareous encrustations . Astrangia.

III. Not adherent.

Lives in sand, not colonial.



ACTINOLOBA (METRIDIUM).

a. Tentacles simple, slightly retractile. Ilyanthus.

b. Tentacles in two sets, posterior opening. Cereanthus.

Body covered in sand, colonial. Individuals not connected with cœnosarc . Edwardsia.

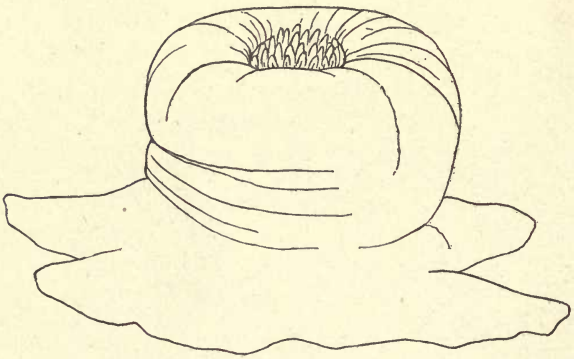
Parasitic in Cyanea . . . . Philomedusa.

A. I.

Actinoloba. Body fixed. Outer surface smooth. Tentacles small, on lobes, retractile. Reproduction; fission,

gemmation and ova. Hermaphrodite. Eggs develop internally. Abundant everywhere at low tide.

A. marginata.



ACTINOLOBA WITH BODY CONTRACTED.

Bunodes. Body with thick walls, covered externally with warts. Tentacles short, not numerous, in four rows.

B. spectabilis.

Polythoa. Polyps in clusters connected by living cœnosarc. Attached to shells inhabited by hermit crabs, worms, etc. *P. parasitica.*

Tealia.[1] Solitary, tentacles in many series. Base large. Body bright red, smooth; when retracted, flat.

T. crassicornis.

nodosa. (?)

A. II.

Lophohelia. Colonial, branched. Polyps irregularly alternate, widely separate. Calycles cup-shaped, slightly protuberant. Axis solid, zigzag. Deep water.

L. prolifera.

[1] Urticina.

Astrangia. Skeleton calcareous encrustations. Not branching. Individuals closely crowded. Corallum circular, sometimes polygonal by crowding. Septa of equal size, not prominent, peripheral wall. Polyps cylindrical, tentacles numerous, dotted with clusters of nematocysts. Terminal clubs. Tentacles retractile. Ova vomited through mouth when laid. South of Cape Cod.

A. Danæ.

A. III.

Ilyanthus. Body free, tapering posteriorly. Tentacles slightly retractile. No posterior orifice.

I. lævis.

Cereanthus. Body elongated, vermiform. Two series of tentacles which alternate with each other. Posterior part present.

C. borealis.

Edwardsia. Colonial, not attached by cœnosarc. Posterior extremity inflated, not perforate, membranous. Tentacles on a retractile column. Motion in retraction rapid. Color white. Young, Arachnactis.*

E. sipunculoides.
farinacea.
sulcata.
carnea.
lineata.

Philomedusa. Body vermiform with posterior sac. Posterior opening? Tentacles few, short, thick, conical.

P. parasitica.

Madreporaria.

Solitary or colonial. Secrete lime skeletons. Tentacles numerous, hollow; no external opening, retractile.

[1] The young of *E. lineata*? is said to be the Actinian parasite of Mnemiopsis.

I. Solitary, not attached[1] . . . . Pennatulacea.
II. Attached.
a. With axis . . . . . Gorgonacea.
b. Without horny axis . . . Alcyonacea.

Body with circular base with calcareous septa. No ring-shaped wall. Six peripheral tooth-like extensions of calcareous septa. Septa large and small, alternating in two or more series. Each septa with lateral ridges. Unattached. Lower surface ribbed. Deep water.

Deltocyathus.

Body horn-shaped, prolonged to a posterior projection. Two axes of different lengths. Peripheral wall. Large prominent septa which rise above the upper surface; no centrifugal peripheral teeth. One series of septa.

Flabellum Goodei.

Alcyonoida.

Compound corals with eight pectinate or branched tentacles. With or without sclerobase. When sclerobase is present, horny, calcareous or siliceous. With a cortical layer formed of consolidated or scattered spicules.

Pennatulacea. Free or with base buried in sand, pen-shaped, composed of an axis and leaf portion. With spicules. Sclerobase small flexible rod. Polyps on edge of leaf. Zoöids small on axis.

Gorgonacea. Rooted, plant-like, branching. With horny or siliceous sclerobase or loosely consolidated spicules in axis. Cortical layer present or absent in dry specimens.

Alcyonacea. Attached, fleshy, with scattered spicules. Massive, colonial. Without sclerobase.

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[1]Deep water; not strictly belonging in this paper.

Pennatulidæ.

Pennatula. Polyp region with prominent flat leaves which are two ranked, opposite. Polyps marginal. Shaft smooth. Color of leaves red, shaft at end white. Phosphorescent. Aperture of polyps with spinose spicules.

P. aculeata.

Balticina. Polyps in oblique rows, two in each row. Leaves not prominent. Calycles (polyps) spinose. Zooids on the axis between the leaves. Axis below the leaves smooth. With terminal polyp. Leaves pale-purple. Axis salmon color.

B. Finmarchica.

Virgulariadæ.

Virgularia. Stem filiform; polyp region linear with sessile curved lobes on upper end. Polyps marginal. Pinnæ wanting.

V. Ljungmanni.

GORGONACEA.

Alcyonacea.

A. Without sclerobase, the axis formed of consolidated spicules.

Alcyonium. Polyps prominent; solitary. Body lobed, with spicules. Prominent circumoral spicules. Pores star-like. Encrusting submerged bodies. White or red, axis generally white.

1. Large, markedly lobed . . . . *A. carneum.*
2. Small, nodose, bright-red . . . *A. rubiforme.*

Paragorgiidæ.

B. With horny or siliceous sclerobase and generally with cortical layer.

1. Sclerobase with nodes and internodes.

Paragorgia.
Anthothela.
Acanella.

2. Sclerobase horny.

Acanthogorgia.
Paramuricea.
Primnoa.

B. 1.

Paragorgia. Coral large, branching with axis formed of spicules. No horny deposit.

P. arborea.

Anthothela. Coral irregular with spiculose axis of fusiform spicules. Calycles prominent, not retractile. Cœnosarc thin. Spicules warty in cœnosarc and calycles.

A. insignis.

Acanella. Branched with nodes larger than internodes. Nodes very hard. Cœnosarc thin. Tentacles stiff with spicules.

A. Normani.

B. 2.

Acanthogorgia. Coral slender, flexible, branched, bushy. Cœnosarc thin with small, curved, wart-like spicules which do not project. Calycles elongated. Disk surmounted by eight groups of long, divergent, spine-like spicules. Body spicula, rarely projecting.

A. armata.

Paramuricea. Differs from Acanthogorgia in possessing shorter calycles and shorter marginal spines. Spicules irregular, flat, branched.

P. borealis.

Primnoa. Central axis horny, branched; cortical layer hard, with difficulty separated from the sclerobase. Calycles protuberant, with scales. Calicular apertures (mouths) with eight scales. Cortical layer rough on external surface.

P. reseda.

IV. ECHINODERMATA.

The animals which are included in the Echinodermata are all marine and are distinguished by a spinous integumentary covering. The integument may be filled with calcareous deposit in the form of sharp, pointed, immovable warts, or plates closely joined together, bearing sculptured and fluted movable spines. In some cases the integument is smooth and has embedded anchor-shaped calcareous spicules. The existence of spines has given the name of the Echinodermata, "hedge-hog skinned," to the group.

The form of the body varies very considerably. It has sometimes the form of an oblate sphere with immovable calcareous plates, as in the sea-urchins. In others the body is soft and vermiform. The majority are star-shaped, in which a central body and peripheral rays can be differentiated. In the ordinary star-fishes the body and rays are with difficulty distinguished. In the group of brittle-stars the body is sharply marked off from the rays which extend as long, highly flexible, worm-like bodies. These rays may be filamentous, as in the feather-stars, or divided and subdivided as in the basket-fishes. In the common star-fish we have ordinarily but five rays, while in the sun-stars the rays are numerous. In the pentagonal star-fishes the interval between the rays is filled up, the tip only extending beyond the five angles, and the distinction between the central body and peripheral arms is almost lost.

The star-shape disappears wholly in the sea-urchins

which have a spherical body with no arms. The body is ordinarily spinous, whence the name of the typical genus, Echinus. In Echinarachnius, the "sand dollar" or "sand cake," the sphere is flattened into a thin, slightly conical disk.

In most of the Holothurians, "sea-cucumbers," the body is columnar; in some vermiform. In this group portions of the body may be covered with scales without prominent spines, but is leathery, or soft and flexible.

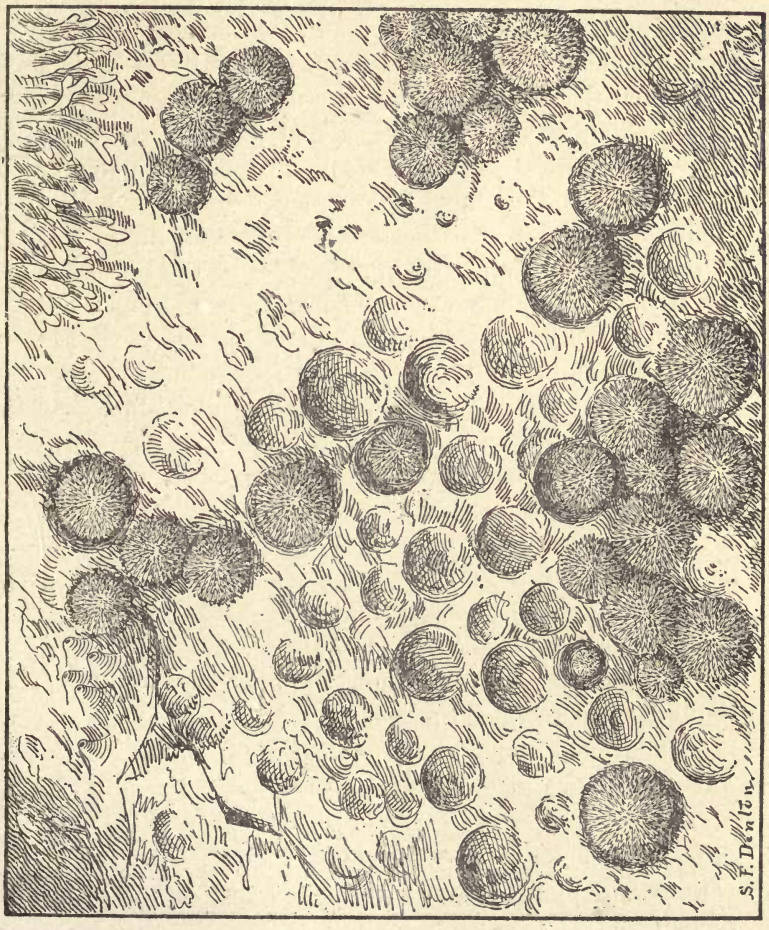
The stellate Echinoderms are distinguished by an oral and an aboral region. The oral region in the star-fishes is situated below; in the Crinoids above, as the animal is ordinarily placed. A mouth is found at or near the centre of the oral region. The vent when present is, in the star-fishes, on the centre of the aboral region. The brittle-stars have no vent.

The oral surface of the star-fishes is formed of five double rows of plates extending from mouth to extremity of the ray. These plates are called ambulacral plates and from the intervals between them arise the feet which are often with suckers at the free end and with a single or paired inflation or ampulla at the opposite end in the body. These feet are in two or four rows in each ray. In the brittle-stars the ambulacral plates are covered by a ventral series of plates or integument.

In the spheroidal Echinoderms the aboral surface of the star-fish is reduced to a small circle at the pole opposite the mouth. The ambulacrals appear as meridional rows of plates extending from mouth to aboral circle. In the "sand dollars" a portion of these plates on the upper surface is specialized into a rosette of five pairs of plates arranged in a series known as the petaloid region. The position of the anus varies in the sea-urchins from the neighborhood of the mouth to a point on the opposite pole

of the body. Our common sea-urchin sometimes excavates cavities in the solid rock.

In the "sea-cucumbers" the structure of the ambula-



SEA-URCHINS IN EXCAVATIONS.

cral plates is obscure. In some genera a foot is formed by the modification of three of these series; in Cucumaria we find five double rows, and in Thyone the suckers are ir-

regularly distributed. Certain sea-cucumbers and brittle-stars have feet destitute of suckers.

The nervous system is exposed to the water in star-fishes, but is covered by a series of plates in brittle-stars and sea-urchins and is internal in sea-cucumbers. Eye-spots are found at the ends of the rays in star-fishes; in a ring about the aboral region in sea-urchins and are wanting in Crinoids and brittle-stars and possibly in sea-cucumbers. Special organs of smell exist on the under or oral surface of the star-fishes as shown by physiological studies. Otocysts are known in deep-sea genera.

The ovarian openings lie in the angles of the rays or in the vicinity of the mouth in star-fishes; in a circle about the aboral region in sea-urchins and on the lateral cirri in Antedon. In brittle-stars there are four broad openings on the side of the disk, called by some genital slits. By many naturalists these are regarded as respiratory openings. Holothurians generally have a single sexual opening near the mouth.

A madreporic body or convoluted prominence is well marked in star-fishes and sea-urchins and hidden or wanting in snake-stars and sea-cucumbers.

The sexes are ordinarily separate. Some star-fishes, snake-stars and the sea-cucumbers are probably hermaphrodite. The Echinodermata have a direct or indirect development, and some are viviparous.

The Echinodermata of our coast are divided as follows:

Free Crinoidea.

Body with pinnate rays, with jointed cirri on the aboral region.

Asteroidea.

Body stellate or pentagonal, with an aboral and oral region, the latter only crossed by five or ten double radial

rows of protrusible legs. No line of demarcation between body and arms.

Ophiuroidea.

Body stellate with a central disk and peripheral arms sharply marked off from each other.

Echinoidea.

No peripheral arms, body spherical or discoidal, spiniferous, inflexible.

Holothurioidea.

No peripheral arms, body columnar, flexible, tegumentary, partially squamous or leathery. Not spiniferous.

ASTEROIDEA.

Body stellate, with no separation between disk and arms. Abactinal region large, flexible, with embedded calcareous deposits. Spines on the abactinal region small. With suckers and ampullæ arranged in two or four rows in each arm. Ambulacral plates not covered. Nervous system and water system of the arms naked. Eye-spots at extremity of the arms. Ovarian openings in the angle of the arms. Madreporic body conspicuous on aboral surface. Stomach and hepatic cœca in both arms and disk. Polian and racemose vesicles. Young a free brachiolarian, or viviparous. Pedicellariæ sessile, biparted.

A. Body stellate, five or six rays.

B. Body stellate, with numerous rays.

C. Body markedly pentagonal.

Asterias. Body star-shaped with normally five arms (six? in one species). Rays with marginal spines and plates, and with four rows of ambulacral plates. Arms long, inflated.

a. Five rays (in normal specimens).

I. Color reddish, madreporic body dull in color. Free larvæ take the form of brachiolaria.

A. vulgaris.

II. Color brownish, madreporic body bright red or more often orange.

A. Forbesii.

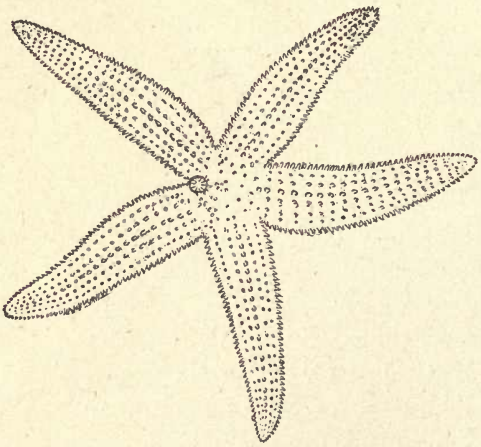
b. Six rays.

Spines scattered, large, slight constriction between arms and disk.

A. polaris.

Leptasterias. Body stellate, five-rayed with prominent scattered spines; color white or light gray. Young viviparous, attached by a cord on the oral region.

L. tenera.

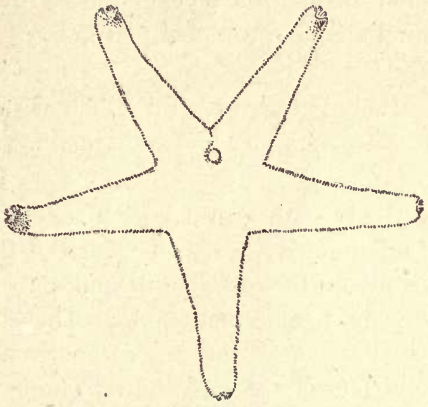


ASTERIAS.

Cribrella. Body smooth, stellate, five rayed, covered with short spines and spine warts, porous integument. Lateral spines small and inconspicuous. Two rows of

sucker-feet. Bright colored. Young bright red. Development direct. Young carried about the mouth.

C. sanguineolenta.



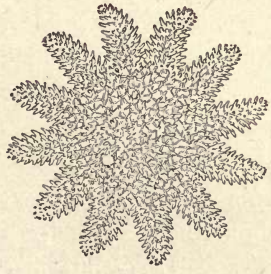
CRIBRELLA.

Solaster. Body smooth with short spines. Lateral spines small or inconspicuous. Radius of disk large as compared with that of the star-fish. Color red.

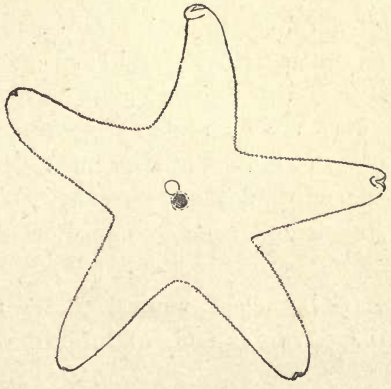
S. endeca.

Crossaster. Body and abactinal region of the rays studded with tufts of spines. Color red.

C. papposa.



CROSSASTER.



PTERASTER.

Ctenodiscus. Aboral surface paved with short, thickly set spines. Madreporic body large. Central protuberance in centre of aboral surface. Edges of rays paved with rectangular plates which bear spines. Rays terminated by a single median rounded plate.

C. crispatus.

Asterina. Body pentagonal, thick, flat with thin margin, destitute of rectangular plates. Small.

A. borealis.

Pteraster. Body with aboral region covered by a thin tent-formed integument stretched over the body poised upon the tips of clusters of aboral spines to which it is joined. Tent-like membrane flexible. There is a central opening in tent-like membrane. Madreporic body hidden and seen by cutting off the covering. Young carried in the groove-formed marsupia extending from the sexual openings to the central orifice. *P. militaris.*

Hippasterias. Body with short, stumpy spines. Bright red color; obscurely pentagonal. Aboral plates of uniform size. *H. phrygiana.*

Ophiuroidea.

Stellate echinoderms with central disk and long, flexible, simple or branched arms. Body markedly separate from the arms. Ventral surface of the arms covered with plates or integument. Stomach and ovaries confined to the disk. No ambulacral suckers; locomotion by spines, hooks and motion of the arms. Viviparous, or young have the form of pluteus.

Rays simple, not branched, ventral plates present.

Ophiuridæ.

Rays branched, ventral plates replaced by a leathery skin. Arms capable of infolding about the mouth.

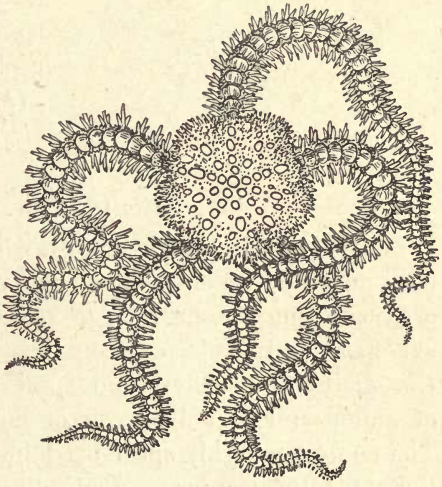
Astrophytidæ.

Ophiuridæ.

Disk circular and tegumentose above, with or without radial plates. No anus. Madreporic body small, or wanting. Arms simple, with aboral, lateral and ventral plates. Ambulacral plates hidden under the ventral. Blood system and nerves covered by ventral plates; feet in single row at edge of the ventral plates, without suckers or ampullæ. Motion by jerks. Hermaphrodite or bisexual. Young has a free pluteus, or adult viviparous. Genital slits large.

Ophiopholis. Disk with small spines. Teeth. No teeth papillæ. Arm-spines flat, stout, arranged on the side plates. Color generally brownish-red. Primary plates in brachial and interbrachial regions. Young, pluteus.

O. aculeata.



OPHIOPHOLIS.

Ophioglypha. Disk with crowded, naked, distorted scales. Radial shields swollen. Arm-spines few (three). Tentacle scales numerous. Color gray with light bands on the arms, also yellowish. Probably viviparous.

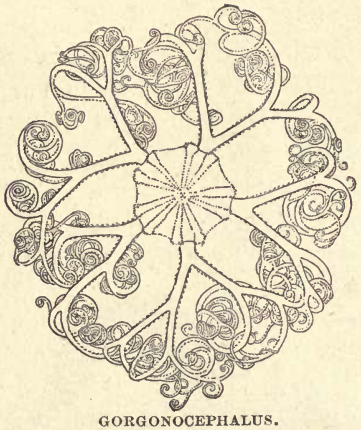
O. Sarsii.

Amphiura. Disk small, delicate, with naked overhanging scales. Arms slender. Arm-spines short. Arms four and one-half times the diameter of body. Color brown. Viviparous.

A. squamata.

Astrophytidæ.

Disk and arms with thick scaleless skin. Radial shields extend to centre of disk, forming elevated radial ribs. Arms branched many times. No arm-spines except at tip of branchlets, where there are microscopic hooklets. Arms folded ventrally. Radial ribs yellow; interbrachial region brown or red. Radial ribs with short conical spines. Interbrachial region of disk smooth or with short spines. Ventral plates replaced by integument. *Gorgonoce halus Agassizii.*



GORGONOCEPHALUS.

ECHINOIDEA.

Body cylindrical, disk-shaped, without arms. Calcareous, inflexible, composed of immovable plates. Apical area with anus or destitute of same. Ovarian openings, eye-spots and madreporic body around the apical area. Locomotion by suckers and spines. Five double rows of ambulacral and five rows of inter-ambulacral plates. The teeth are highly specialized into an apparatus called the Aristotle's lantern. Pedicellariæ pedunculated, trifid.

I. Echinoids. Body spherical with ambulacral zones equal in length, unmodified from apical to oral region. Aristotle's lantern. Development with pluteus. Ovaries five.

II. Clypeastroids. Body flat, disk-shaped; ambulacral openings on the aboral surface, modified into five pairs

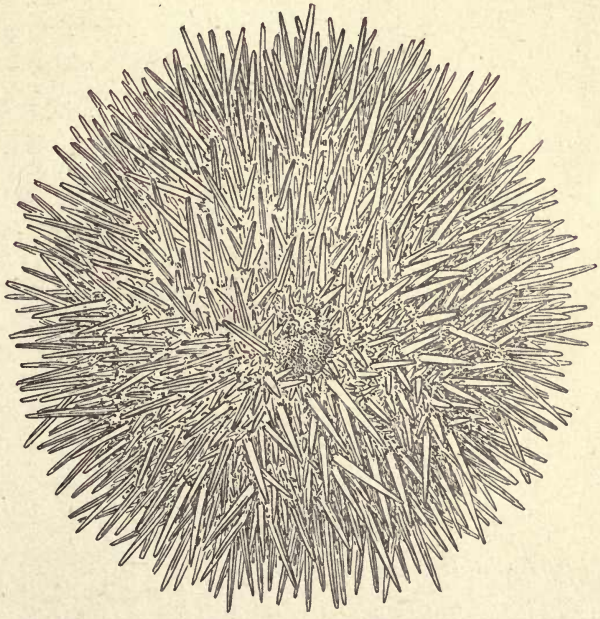
of petaloid openings. Anus on edge of disk. Aristotle's lantern. Development with pluteus. Ovaries five.

III. Spatangoids. Body swollen, globular, elongated. Ambulacral zones of different lengths, and more or less modified mouth and vent asymmetrical. No Aristotle's lantern. Development with pluteus. Ovaries four.

Echinoids.

Arbacia. Body globose; vent and mouth opposite; two kinds of spines, the larger few in number; color purple. Anus closed by four triangular plates. Pluteus with two lateral anal rods.

A. punctulata, Lam.



STRONGYLOCENTROTUS.

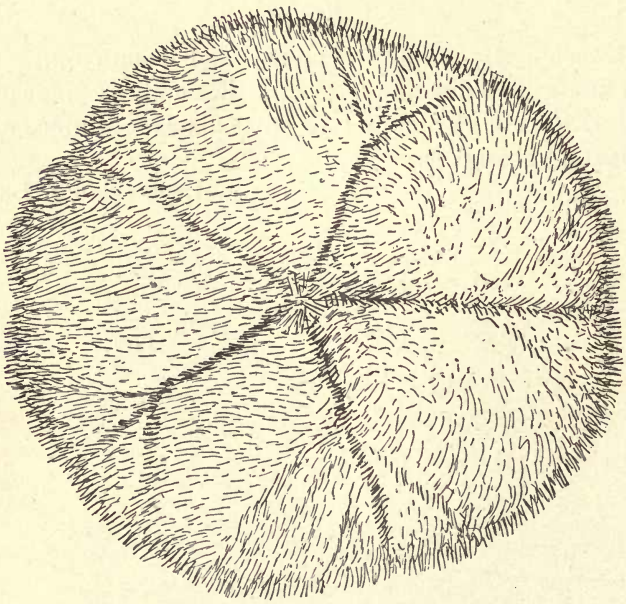
Strongylocentrotus. Body globose; anus and mouth opposite. Spines of one kind, short, small, greenish color.

Apical area with irregular plates. Pluteus without anal rods.

S. Dröbachiensis.

Clypeastroids.

Echinarachnius. Body nearly circular, very flat with sharp, entire margin. Vent close to edge. Petaloid re-



ECHINARACHNIUS.

gion marked. Spines small, short, brown or reddish color. Pluteus without anal rods.

E. parma.

Spatangoids.

Schizaster. Body heart-shaped, irregular, oval with avenues on the upper surface. Mouth asymmetrical. Test thin, fragile. Ambulacral zones depressed and petaloid. Pluteus with single median calcareous rod on the anal lobe.

S. fragilis.

Holothurioidea.

Body elongate, vermiform with oral and anal openings at opposite poles of the animal. Skin leathery often covered with scales, sometimes spinous, often with embedded spicules or anchors. Ambulacral suckers wanting or present. When the latter are present, in three to five rows.

With suckers . . . . . Pedata.
Without suckers . . . . . Apoda.

Pedata.

Cucumaria. Suckers in five regular rows, alternate in each row, closely oppressed. Tentacles ten. Dental apparatus.

C. frondosa.

Lophothuria. Suckers in three rows and on one side which forms a soft foot. Other ambulacral furrows rudimentary; absent. Body covered with scales. Tentacles ten.

L. Fabricii.

Thyone. Body with scattered wart-like suckers. Tentacles ten. Teeth filamentous.

T. scabra.
elongata.

Apoda.

Caudina. Body long, whitish without suckers, prolonged into a long appendage at one end (anal). No "respiratory tree."

C. arenata.

Leptosynapta. Body vermiform, long, transparent. No suckers. No jaws. Tentacles long, divided into finger-like branches. Respiratory tree.

L. Girardii.

Larvæ of Echinoderms.

The larvæ of New England Echinoderms are either carried by the mother or free-swimming. The development

is either direct (without metamorphosis) or indirect. The larvæ of the free-swimming kind are as follows:

A. With long flexible ciliated arms. Transparent. Brachiolaria.

B. With long inflexible ciliated arms. Each arm with calcareous axis . . . . . Pluteus.

C. No arms, with rounded prominences, not ciliated, bright red, opaque . . . . . False pupa.

D. No arms, barrel-shaped, girt by parallel bands of cilia . . . . . Pupa.

E. No arms, with irregular lines or bands of cilia. No eye-spots.

1. Single convoluted band about mouth. Young Brachiolaria.
2. Double convoluted band non-continuous. Auricularia.

A. Brachiolaria.

The Brachiolaria is the young of the star-fish, Asterias. It has a bilateral arrangement of long flexible arms. Transparent, slightly pigmented arms. With large open mouth, œsophagus and intestine. Elongated water-tube on each side of stomach. Dorsal pore. Young star-fish appears on left water-tube at or near region of stomach.

B. Pluteus.

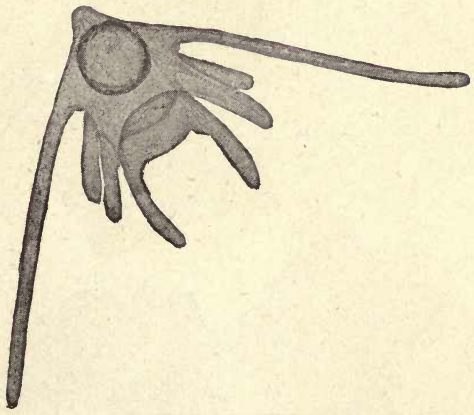
1. Pluteus with two arms, very long . Ophiopholis.
2. Pluteus with anal arms . . . . . Arbacia.
3. Pluteus with epaulettes . . Strongylocentrotus.
4. Pluteus without epaulettes . . Echinarachnius.

The pluteus is the larval condition of the Ophiuroidea and Echinoidea. It is distinguished by the possession of calcareous axes in the arms.

1. The adult pluteus of Ophiopholis has two arms very much longer than the others.

2. The pluteus of Arbacia has eight oral and two anal arms. No other New England pluteus has the two anal arms as far as known.

3. The pluteus of Strongylocentrotus has eight oral arms and epaulettes, ciliated appendages formed by the outgrowth of the ciliated chords at the angle of the junction of the arms (larger) with the body.



PLUTEUS OF OPHIOPHOLIS.

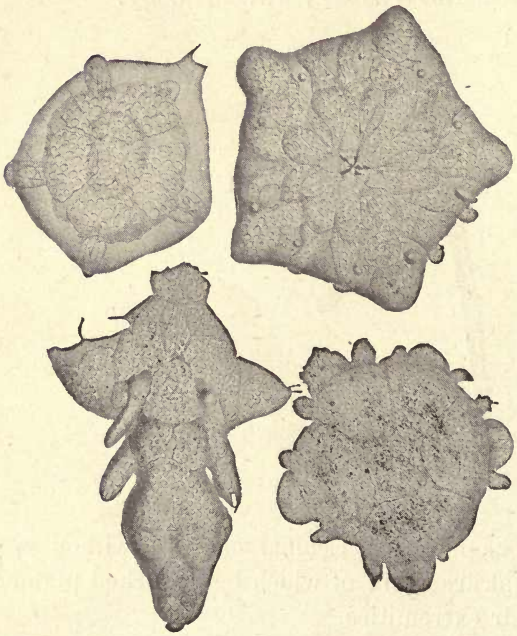
4. The pluteus of Echinarachnius is without epaulettes, with eight arms, six of which bear marked pigment spots near their extremities.

C. False pupa.

The false pupa is probably a young of Lophothuria. It is globular, bright red in color, opaque, with a cluster of knobs at one pole and two knobs on one side. The former develop into the tentacles of the adult, the latter into feet of the soft foot-like region of the body.

D. Pupa.

A pupa has been found at Newport which is referred to Leptosynapta. Body, barrel-shaped, girt by rows of cilia in bands. Mouth at one extremity and tentacles seen through the body walls. Calcareous deposits in the walls under the ciliated bands. The young of this pupa is an Auricularia.



YOUNG OF AMPHIURA.

Attached young.

The young of the following New England genera of Echinoderms are attached, borne on the mother or have an indirect development.

OPHIURANS.

Amphiura squamata.

This species is hermaphrodite and the young reach a stellate form before they leave the parent. Provisional spines corresponding to the plutean spines are developed, to be later lost.

Ophioglypha Sarsii.

Said to be viviparous?

ASTEROIDS.

Larva with club-shaped, opaque larval body carried about the mouth. Color, white or brownish.

Leptasterias.

Larva without club-shaped body. Color, bright red, carried in a pouch made by an infolding of the mouth.

Cribrella.

Larva carried in pouches between a tent-like covering on the back and the back (aboral) region of the adult.

Pteraster.

No Echinoid found in New England is known to have a direct development.

Asterina.

GENERAL DIRECTIONS.

As will be noticed, the preceding pages are almost wholly devoted to means and methods of collecting, and identifying unknown Cœlenterata and Echinodermata when they are found. It likewise seems appropriate in an article of this nature to aid the collector by approaching the subject from a somewhat different side. Where shall one go, and how collect certain of these animals the systematic position and name of which are known? Information as to the locality where any desirable genus of these groups can be found without failure, and hints as to special methods to be followed in procuring it may also with advantage form a part of this work. Teachers desiring for instance a supply of star-fishes or sea-urchins for class instruction might regard it a help if some information be imparted in this direction. Hints as to how to procure certain typical larval forms may also not be out of place here.

I have therefore chosen a few available types from each group, and endeavored to offer suggestions as to modes of collecting and places to be visited, which rarely fail to reward the collector.

Some of the Cœlenterata and Echinodermata are gregarious; others live apart more or less isolated. The time and place of the appearance of nomadic animals are not constant, and no rule can be laid down which will be sure to guide one in the collecting of such genera. Moreover, the home of many may vary in different months, and even

some of the sedentary genera may retire to deep water in certain seasons. Except that one might mention a locality where he had collected them, it is next to impossible to direct a collector to a place where the large majority can always be found without failure.

Among the Hydrozoa the problem of habitat is perhaps more difficult to solve than among the other groups. Most of the free genera are so sporadic in their appearance that it is difficult to say where one should go on any fixed date, and not be prepared for failure. The places where these have been taken are so widely spread along our coast that they may be said to occur anywhere along the shore, but for the great majority of nomadic genera there is great uncertainty that at any definite time they can be found in numbers at any one of these places. With the fixed hydroids it is however different, on account of the nature of their habitat.

The several genera of fixed hydroids prefer as a general thing a rocky bottom just below low-tide mark. Their favorite habitats are rocky cliffs exposed to the sea, or quiet pools left by the retreating tide. They are also fond of the fronds of Laminaria and Fucus, buoys and submerged parts of wharves and landing stages. The bottoms of boats which have been continuously in the water for some time are often covered with these animals. Although the majority are to be found in these and similar places there are a few which are attached to the sand or live in the mud.

Clava leptostyla, which may be taken as an available type of the so-called Tubularian hydroids can always be found at low tide on the small ledge of rocks near Beverly Bridge. This locality I have repeatedly visited for the purpose of collecting Clava, and have never been disappointed in obtaining a large number. It is found attached to the Fucus which hangs from these rocks into the water.

Tubularia indivisa can always be found at low tide clinging in clumps to the piles of Beverly Bridge, just below low-water mark. With it are associated great numbers of Campanulariæ and Obelias.

If one wishes the common Sertularia (*S. pumila*), one of the best collecting places for this most common hydroid is Revere Beach at low tide. Almost every fragment of Laminaria or "oarweed" washed up after a storm will be found to be peopled with this delicate species. It is moreover common at all times of the year.

The shells of Lunatia inhabited by the so-called hermit crab are favorite habitats for *Hydractinia echinata*, but it is also found encrusting submarine objects, floating logs, water-soaked ropes, and the under surface of buoys.

I am not acquainted with a single locality which will always reward the collector with numerous specimens of the different genera of Ctenophora and Siphonophora, although it is safe to say that a few weeks at Eastport with constant examination of the water about the wharves will probably reveal a limited number of specimens of Beroë and Bolina, and possibly an unexpected multitude of *Nanomia cara*.

I have found the ebb tide at the "draw" at Beverly Bridge to sometimes bring down many large examples of the acraspidote medusa, *Aurelia flavidula*, but as with all floating jelly-fishes no locality can be mentioned where it can be found without failure in quantities. *Cyanea arctica* may sometimes be seen by the score about the Boston docks and near the bridges, yet many visits to these places might be made without seeing a single specimen. Dactylometra and Callinema are rare Acraspeda.

Our most common Actinian, *A. marginata*, can always be collected in abundance on the piles of Beverly Bridge. This is one of the most easily obtained of all of our ma-

rine animals, and can be had in quantity in every month of the year. As it is very hardy it can readily be transported alive, and kept in good condition for some time in the class room.

Alcyonoids are as a rule not gregarious and must be obtained by dredging. I can recommend for some of the genera of this group the broken shelly and clay bottom half-way between Eastport and Campobello. One or two of the genera attach themselves by preference to the interior of broken Mytilus shells, but they are rarely found in multitudes, although at a single haul of the dredge at the place mentioned I have often taken more than a dozen.

Echinoderms are found on rocky or clay bottoms, in sand, among broken shells and in the coralline zone, from moderate depths to the line of low tide. Among the Ophiuroidea, *Ophiopholis aculeata* can always be found just below low tide at Nahant. It is a habit of this and some other genera of snake-stars to avoid the light, so that one must search for them under stones and in the crannies and crevices of rocks or similar secluded places. If a large number of Ophiopholis is desired, a visit to Clarke's ledge, Eastport, will reward the collector with as many as he can well take care of.

The best grounds for collecting *Gorgonocephalus Agassizii* are the Race off Race Point, Provincetown, and the Channel at Eastport off the Old Friar, Campobello, but this genus can never be found in shore collecting. The genus is gregarious.

Asterias, the common star-fish, is found in abundance in many localities. A visit to Beverly Bridge, Revere Beach or Nahant, is sure to reward the collector with at least a few. If one wishes a larger number, Eastport, or best of all Grand Manan will be more profitable. Cribrella, like most of the other star-fishes, prefers a rocky bottom, but

occurs at times on a sandy shore. Crossaster is a rare starfish and no assurance can be given as to the certainty of finding it in numbers in any single locality. Razor Island, Eastport, almost always contributes a few specimens of Pteraster and Ctenodiscus to the dredge. The latter genus can be dredged in abundance off Treat's Island, Salem.

Decaying meat or fish is a good decoy for many Echinoderms, especially star-fishes and sea-urchins, and when a box is baited with this and left over a tide under water these scavengers are generally found collected in it.

The Echinoids make their homes on both rocky and sandy bottoms. If one wishes a large number of Strongylocentroti he will find them almost anywhere along the Maine and Massachusetts coast where there is a rocky shore. At low tide at Grand Manan one can gather them by hundreds and the sea bottom of the littoral zone is there paved with these animals at certain points. The largest area which I have ever seen covered with these animals is near Mr. Cheeney's house at the Point, Nantucket Island, Grand Manan, but it is also very common at Eastport and farther south.

Echinarachnius parma prefers sand as a dwelling place. It can be dredged in great numbers off Revere Beach, in Provincetown Harbor and off Ipswich Beach. The channel which separates Nantucket from the main island of the Grand Manan group is a very profitable dredging ground for these animals. The Cove at Eastport and the adjoining beach afford a sheltered habitat for this genus.

The Holothurioidea live on gravelly, clayey or rocky bottoms, and some genera prefer to burrow in the sand.

Pentacta frondosa lives in numbers in the Eastport waters and can be dredged a half mile from the wharf. Indian Island is a profitable place to visit for this species

for in the waters near by it is more common than elsewhere. The days following a violent storm almost certainly find Revere Beach strewn with multitudes of *Caudina arenata*. Leptosynapta is abundant in the littoral zone in front of the large hotel at the Point of Pines, but it must be dug out of the sand for it lives buried in the beach. I have never discovered a good locality where more than a few specimens of Cucumaria can be found on a single collecting trip.

A few special hints in regard to collecting ova and younger larval stages may have some value.

A means of obtaining the free Medusæ of the Hydroida is to keep the attached hydroid in an aquarium until the zoöids are dropped. In that way, if successful, a large number of individuals may be obtained, but the collector must be prepared to meet with many failures, for most of the hydroids are not hardy, and the laws[1] which determine the time when individual hydroids mature their zoöids are not easily formulated. Obelia, Campanularia, Syncoryne, and Clytia are good genera to use in endeavors to raise the zoöids.

Artificial fecundation may in some cases be resorted to for an abundant supply of the young of several of the New England Cœlenterata and Echinodermata. While it will probably be found that a majority of the genera composing these groups can be successfully reared in this way, up to the present time only a few have been experimented upon with satisfactory results.

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[1]Various circumstances probably retard or accelerate the rate of growth of the young of the Cœlenterata and Echinodermata. One of the most important is, possibly, difference of temperature. As the temperature rises Ophiopholis eggs mature more rapidly, and pass through their segmentation and larval conditions more quickly, and the same may also be the case with many other genera. Various other conditions, as amount of food, also have an important influence on the time of ovulation and the rate of growth of larvæ, so that until these facts are better known it is not possible to understand completely the laws governing periodicity of ovulation and growth.

Possibly the best success in this line has been with the Echinoderms. *Echinarachnius* is a good genus from which to obtain a series of larvæ by artificial fertilization. The sexes are distinct, male and female sexual glands being found in different individuals. While it is not always possible to determine the sex by external coloration, an examination of the interior just under the middle of the upper side will easily betray it. To artificially fertilize Echinarachnius the observer may first make a ring-shaped incision through the aboral calcareous wall allowing the animal meanwhile to remain in the water. Carefully remove the incised portion, and suck up in a pipette a few fragments of the dark red organs which lie just about the apex. Place these in a watch crystal filled with pure water, and if the fragments thus transferred contain ova they will soon give up little transparent globules dotted with bright red spots. The ovaries are dark red, and the spermaries white or yellow.

When a larger quantity of ova is desired, place the female Echinarachnius in a small dish, glass preferred, and with gentle streams of water from the pipette wash out the small globular eggs with care, and then remove the Echinarachnius and larger fragments of the ovary which may have been ruptured from the gland. Then suck up a small quantity of the white fluid from the male Echinarachnius into the pipette and place it in the watch crystal or dish with the ova. Stir the mixture gently and set aside for an hour and a half at which time, if the process has been a success, the ova will begin to segment. The young plutei can be easily reared from these eggs in great quantities, but care must be taken to change the water at least every two days. It is also well to pick out any fragments of sexual glands which may befoul the liquid.

A limited number of Amphiura young may be collected in August and September, possibly in other months, in the

following way. If a gravid specimen is kept in the aquaria a short time the young may crawl out through the genital slits and will then be found in the jar in which the adult is kept. If it is desirable to hasten the parturition the top of the disk of the parent may be removed and then the young washed out gently with a pipette from the sacs in which they are formed.

The young of Pteraster must be searched for in the grooves on the back covered by the tent-like membrane which is stretched from the tips of the spine; those of Leptasterias may be found attached near the mouth.

Asterias may be artificially fertilized and ova collected in numbers by a method similar to that described for Echinarachnius. Strongylocentrotus and Arbacia can also be treated with success by the same method.

It may happen in surface fishing that a large number of Cœlenterata and Echinoderm larvæ may be taken with the dip net in the method described under the use of that instrument. This method of collecting, however, does not yield the numbers, except in exceptionally good fishing that one can obtain by keeping the adults in confinement until the eggs are dropped or impregnated by artificial methods.

The collecting of young Cœlenterata and Echinodermata with the dip net to fill out a series has one among many advantages. From the fact that there is a slight variation in the time of ovulation, larval stages of marine animals in all conditions of growth may often be fished out of the sea in the same excursion. It thus happens that, for instance, in the case of the star-fish one may find the stages of growth from the youngest gastrula to the brachiolaria in the same collecting trip. By the method of collecting with a dip net it is thus possible to obtain more

hardy[1] specimens of older stages which sometimes through various causes have lost their vitality when raised in confinement.

The time of the year which is best suited for collecting depends closely upon the genera desired. For shore collecting and dredging, all the summer months are equally good depending on the state of the weather. Sedentary genera are not sensitive to the various conditions of winds, calms, tides, and other influences. With floating marine animals and the various larval forms of most sedentary genera the problem is somewhat different. Their appearance and abundance vary[2] from month to month and from year to year. It is difficult to say what month of the summer is best for collecting larval Cœlenterata and Echinodermata. The strong autumnal winds blow to the shore a large number of floating genera, but the number of quiet days in each month when these approach the surface of the water is limited. In midsummer months the weather is less boisterous and opportunities to capture animals are greater. My experience has taught me that August and September are more profitable for collecting floating genera than June and July. There is, of course, a connection

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[1]For some reason unknown to me some larvæ after having been raised through a number of early conditions invariably die, and new fishing has to be resorted to for more advanced stages. This is no doubt in most instances due to imperfect aeration of the water, neglect to provide proper food, or lack of proper care. The treatment of larvæ in confinement must vary more or less with the different genera.

[2]The periodicity in the time of the appearance is by no means constant. In some years great multitudes of certain medusæ appear day after day, and on a subsequent year not a single individual will appear. On my first visit to Grand Manan thousands of the beautiful Siphonophore, *Nanomia cara* were seen everywhere in the water so that they literally clogged my drag net. Suddenly, however, these all disappeared and in succeeding years in the same months I did not see a single individual. Every naturalist can probably mention similar equally remarkable instances of the sporadic appearance of some genus of marine life, and I am not familiar with any satisfactory explanation of the phenomenon.

with the time of ovulation for many genera cast their ova throughout the summer, although the ovulation of a majority is probably in the spring. Violent winds interfere with dredging and drive most of the floating life far below the surface. The early morning generally gives the smoothest water and at that time the sea often has a glassy calm which is most advantageons for the capture of many genera. Night collecting is claimed by many to yield the greatest number and variety of floating life.

The ever-increasing interest in the study of the marine surface fauna renders it timely that observations be recorded and tables be prepared containing the dates when pelagic larvæ of different genera can best be collected in some well-known locality. It would, to mention one of the advantages of a table collated from such observations, be of great help if anyone desirous of studying these animals could accurately know when the larvæ or adults with ova are most likely to be found, and could regulate his visit to the seashore by the information thus afforded. In some of the older marine zoological stations in Europe this has been done either in the form of card catalogues or published faunal lists with dates and places of capture.

It has been shown that there is a pronounced periodicity in the occurrence of these larvæ, and year after year an abundance of marine larvæ is looked for in certain months and at no other time.

It is not in the scope of this paper to consider why this is so, and if it were the author has many doubts whether anyone is familiar with enough data to suggest any satisfactory explanation for it. Continued observation for a number of years is necessary to arrive at any trustworthy conclusion, and it is desirable to gather statistics enough to justify general conclusions in regard to the probable time when larvæ can best be obtained for study. Most of the observations

on the time of the appearance of pelagic animals have been made in the summer months and very little is known of the genera characteristic of winter months. Our rigorous climate, however, does not invite collecting at that time and probably very little embryological work could be successfully carried on in the colder months. Of the life which I have collected in midwinter by surface fishing, larvæ and young form a very small proportion of the whole.

Every collector has his own preference for the best place to visit to collect marine animals, and it is not strange that it generally corresponds with the place which he has most often visited. I have worked at only a few stations in New England and am no doubt prejudiced in their favor. The wealth of floating life at Newport is the greatest known to me on the New England coast, but in the few excursions I have made at Wood's Holl, it has seemed to me that there was little difference in the amount of floating life in the two places.

For dredging, however, neither of these places can compare with Eastport and Grand Manan. The latter place is a paradise for the collector of Cœlenterata and Echinodermata. Several circumstances combine to make it such. The enormous tides which sweep around the islands lay bare a littoral zone of great breadth. They also, since their volume is so great, bring a large number of floating animals from deep water. "The opportunities for work at Grand Manan with the dip-net in the study of free-swimming animals are very great. The student of these forms of life is particularly recommended to visit the so-called "ripplings" or tide eddies, several miles from the shore, near the line where the platform of the islands sinks to the deeper sounding of the Bay of Fundy. These eddies are favorite feeding places of many marine animals,

from the whale to the minute Medusæ and Crustacea, and at a proper time of the tide afford most profitable collecting places." The distance from the shore and the difficulty of access are the only drawbacks, but if possible they should be visited by every collector who is interested in the collecting of marine life in its natural habitat. A world for investigation here awaits the attention of the naturalist.

An advantage in working at Grand Manan is the ease with which delicate marine animals can be kept alive in small aquaria for a considerable time. The water is very cold and the change in temperature not as sudden as in more southern parts of New England. My experience has been that the difficulty in keeping the water in small glass vessels used for aquaria at an even temperature with that of the bay is not as great in northern New England stations as in southern and the consequent danger of mortality is lessened. The constant fogs, however, are drawbacks which limit the number of days when collecting can be prosecuted. The small island of Nantucket[1] of the Grand Manan group is most favorably situated for a laboratory or for a point from which to reach the different collecting grounds.

The reader is reminded that there is no one locality on our coast where all the genera here recorded can be collected. Marine animals have their homes which are limited by as sharply drawn lines as those of any forms of organic life. Continued research on the facies of the New England marine fauna indicates the existence of conditions on the coast which separate the northern from

[1] Grand Manan had on my visits a tri-weekly communication with Eastport by a small steamer. Eastport can be reached from Boston by the steamers of the International line, also called the St. John's steamers. There is a daily stage from North Head, the landing place of the steamer from Eastport to Grand Manan, to Woodward's Cove, which is near Nantucket island. Comfortable accommodations can be had at Mr. Cheney's home on the island.

the southern faunas by a line of demarcation of the most rigid character. The coast of Maine and Massachusetts bay is bathed by a cold Arctic ocean current which is replaced south of Cape Cod by warmer water. Although several genera straggle from one zone into the other, the majority are limited to their homes by this powerful climatic influence. Hence it is that one may expect to find a great difference in the marine life of Narragansett Bay and that of the Bay of Fundy, and while I have attempted to consider both in this article even the best of collecting places will not yield more than a small proportion of the genera considered. That part of my work which deals with floating life and with larval forms is necessarily very incomplete.

LIST OF CŒLENTERATA AND ECHINODERMATA FOUND IN NEW ENGLAND.

In the accompanying list I have mentioned the majority of the genera and species of Cœlenterates and Echinoderms which occur in New England waters. It is believed that this list includes the more common species of these animals which the teacher is liable to collect on his excursions. The identification of the majority of the animals of the list will, it is hoped, be facilitated by a knowledge of the generic and specific differentiation indicated by the diagnosis which is given of the more common types.

HYDROZOA.

HYDROIDEA.

Acaulis primarius Stimpson.
Aglaophenia arborea (Desor) Verrill.
Antennularia Kirsch.
Blastothela rosea Verrill.
Bougainvillea superciliaris Ag.

NOTE.—The figures of *Modeeria* (*Turritopsis*), *Zanclea* and *Cunina*, in the preceding pages were originally published in works by the author from drawings loaned him by Dr. A. Agassiz; that of *Acaulis* from drawings by Prof. A. Hyatt. To these naturalists and to all others to whom the writer is indebted, in the preparation of this Aid, the writer takes this occasion to express his appreciations of his obligation, and his sincere thanks.

Calycopsis typa Fewkes.
Calycella plicatilis Hincks.
" humilis Hincks.
" producta G. O. Sars.
" pygmæa Hincks.
" syringa Hincks.
Campanularia caliculata Hincks.
Campanularia flexuosa Hincks.
" *fragilis* Hincks.
" *neglecta* Hincks.
Campanulina acuminata Alder.
Cladocarpus cornutus Verrill.
" *spectabilis* Verrill.
" *Pourtalesii* Verrill.
Clytia bicophora Ag.
Clytia intermedia Ag.
" *cylindrica* Ag.
" *Johnstoni* Hincks.
Cladonema radiatum Dujardin.
Clavatella Hincks.
Clava leptostyla Ag.
Clavula vesicaria Verrill.
Corymorpha nutans Sars.
Coryne (Gaertner).
Cunina discoides Fewkes.
Cuspidella costata Hincks.
" humilis Hincks.
Dicoryne flexuosa G. O. Sars.
Diphasia fallax Ag.
" rosacea Ag.
" mirabilis Verrill.
Dinematella cavosa Fewkes.
Dipurena strangulata McCr.
Dysmorphosa fulgurans A. Ag.
Ectopleura ochracea A. Ag.
Eucheilota ventricularis McCr.
Eudendrium ramosum Ehr.
" dispar Ag.
" rameum Johnston.
" cingulatum Stimp.
" capillare Alder.
" tenue A. Ag.
Euphysa virgulata A. Ag.
Eutima gracilis Fewkes.
Filellum (see Reticularia) Hincks.
Gemmaria gemmosa McCr.
Grammaria abietina Sars.
Globiceps tiarella (McCr.) Ayres.
Gonothryrea hyalina Hincks.
" *Lovenii* Allman.
" *gracilis* Allman.
Gonothryrea tenuis Clark.
Halopsis cruciata A. Ag.
" *ocellata* A. Ag.
Hydrallmania falcata Hincks.
Hydractinia echinata Johnston.
Hybocodon prolifer Ag.
Halecium gracile Verrill.
Halecium articulosum Clark.
" *Beanii* Johnston.
" *muricatum* Johnston.
Hydrichthys mirus Fewkes.
Lafœa pocillum Hincks.
" *dumosa* Sars.
" *grandis* Hincks.
Lafœa robusta Verrill.
Lafœa fruticosa Sars.
Lafœa gracillima Sars.
Leptoscyphus Allman.
Liriope scutigera McCr.
Lizzia octopunctata Forbes.
Lovenella gracilis Clark.
Lytocarpia myriphyllum Kirch.
Mabella gracilis Fewkes.
Melicertum campanula Esch.
Modeeria (Turritopsis) multitentaculata Fewkes.
Myriothela phrygia Sars.
Nemopsis Bachei Ag.
Obelia gelatinosa McCr.
Obelia flabellata Hincks.
" *diaphana* Allman.
" *geniculata* Hincks.
" *polygena* (A. Ag.)
" *parasitica* (A. Ag.)
" *pyriformis* (A. Ag.)
" *fusiformis* (A. Ag.)
" *dichotoma* Hincks.
" *longissima* Hincks.
Oceania languida Ag.

Operculariella lacerata Hincks.
Ophiodes mirabilis Hincks.
Parypha crocea Ag.
Pennaria gibbosa Ag.
Perigonimus Sars.
Podocoryne carnea Sars.
Ptychogena lactea A. Ag.
Plumularia Verrillii Clark.
Reticularia serpens (*Filellum serpens*) Hincks.
Rhizogeton fusiformis Ag.
Sarsia mirabilis (see Syncoryne) Ag.
Salacia robusta Hincks.
Sertularia abietina Lin.
" *filicula* Lin.
Sertularia argentea Ellis & Sol.
S. argentea, var. *divaricata* Clark.
Sertularia latiuscula Stimp.
" *cupressina* Lin.
" *pumila* Lin.
Sertularella tricuspidata Hincks.
" *rugosa* Gray.
Sertularella polyzonias Gray.
S. polyzonias var. *gigantea* Hincks.
Sertularella Gayi Gray?
Stauridium Dujardin.
Staurophora laciniata Ag.
Stomobrachium tentaculatum Ag.
Syncoryne mirabilis Allm.
Syncoryne reticulatum (A. Ag.).
Stomatoca apicata Ag.
Thamnocnida spectabilis Ag.
" tenella Ag.
Thaumantias Eschscholtz.
Tiaropsis diademata Ag.
Tima Bairdii Ag.
Tubularia indivisa Lin.
Tubularia Couthouyi Ag.
" *stellifera* Couth.
Tubiclava cornucopiæ Norm.
Thuiaria articulata Flem.
Trachynema digitalis A. Ag.
Turris episcopalis Fewkes.
Willia ornata, McCr.
Zygodactyla Grœnlandica Ag.
Zanclea (see Grammaria) Gegenbaur.

SIPHONOPHORA.

Agalmoides elegans Fewkes.
Diphyes sp.
Diplophysa inermis Gegenbaur.
Eudoxia Lessonii Huxley.
Nanomia cara A. Ag.
Physalia arethusa Til.
Porpita sp.
Velella mutica Esch.

ACRASPEDA.[1]

Aurelia flavidula Per. et Les.
Callinema ornata Verrill.
Cyanea arctica Per. et Les.
Dactylometra quinquecirra A. Ag.

To these are allied the Lucernaridæ for which the reader is referred to H. J. Clark and E. Haeckel, System der Medusen.

Haliclystus auricula Clark.
Halinocyathus platypus Clark.
Lucernaria quadricornis Müll.
Manania auricula Clark.

CTENOPHORA.

Beroë roseola (Ag.).
Bolina alata Ag.
Lesueuria hypoptera A. Ag.
Mertensia ovum Mörch.
Mnemiopsis Leidyi A. Ag.
Pleurobrachia rhododactyla Ag.

[1]This group has been known by several names of which Discophora and Scyphomedusæ may be mentioned. At the present time the latter is thought by some naturalists to be the best name for the group.

ACTINOZOA.

ALCYONOIDA.

Acanella Normani Verr.
Acanthogorgia armata Verrill.
Alcyonium rubiforme Ehr.?
" carneum Ag.
Anthothela insignis Verrill.
Balticina Finmarchica Gray.
Cornulariella modesta Verrill.
Paragorgia arborea Edw. & Haim.
Paramuricea borealis Verrill.
Pennatula aculeata Dan.
Primnoa reseda Verrill.
Virgularia Ljungmanni Köll.

ACTINOIDA.

Actinoloba marginata Edw. & Haim.
Astrangia Danæ Agassiz.
Bolocera Tuediæ Gosse.
Caryophyllia borealis (Mosely).
Cereanthus borealis Verrill.
Deltocyathus Agassizii Pourtales.
Edwardsia sipunculoides Stimp.
" lineata Verrill.
Epizoanthus Goodei Verrill.
Flabellum angulare Mosely.
Ilyanthus lævis Verrill.
Lophohelia prolifera Edw. & Haim.
Philomedusa parasitica (Verr.)
Tealia nodosa (Fabr.).
" crassicornis.

ECHINODERMATA.

HOLOTHURIOIDEA.

Caudina arenata Stimp.
Chirodota læve Grube.
Cucumaria frondosa Jæg.
Leptosynapta Girardii Verrill.
Lophothuria Fabricii Verrill.
" squamata Verrill.
Molpadia oölitica Pourt.
Molpadia *turgida* Verrill.
Pentacta minuta (Fabr.). Verrill.
Pentacta calcigera Stimp.
Pentacta assimilis (Dub. & Kor) Verrill.
Psolus phantapus Oken.
" regalis Verrill.
Stereoderma unisemita Ayres.
Thyone scabra Verrill.
" elongata (Ayres) Verrill.
Thyonidium hyalinum (Forbes) Norm.
Thyonidium productum Stimp.

ECHINOIDEA.

Arbacia punctulata Lam.
Echinarachnius parma Gray.
Strongylocentrotus Dröbachiensis A. Ag.
Schizaster fragilis Dan. & Kor.

ASTEROIDEA.

Asterias vulgaris Stimp.
Asterias Forbesii Verrill.
Asterias stellionura Perrier.
Asterias polaris (Müll. & Tros.) Verrill.
Asterina borealis Verrill.

Cribrella sanguineolenta Lütk.
Ctenodiscus crispatus Dan. & Kor.
Crossaster papposus Müll. and Troschel.
Leptasterias tenera (Stimp.) Verrill.
Leptasterias compta (Stimp.) Verrill.
Hippasterias phrygiana Agassiz.
Pteraster militaris Müll. & Trosch.

OPHIUROIDEA.

Amphiura squamata Lyman.
Amphiura tenuispina Ljung.
Gorgonocephalus Agassizii Stimp.
Ophiacantha bidentata Ljung.
Ophioglypha Sarsii Lym.
Ophiopholis aculeata Gray.

NOTE.—The author has indicated by italics in the above list several genera and species which cannot be identified by the use of the "Aid." In addition to these there are several others which the author has never seen, and others which more properly belong to deep water than to the regions indicated for the scope of this article. For the introduction of these the author claims the kind indulgence of the reader. Many genera found in very deep water are omitted.

The author's studies of marine animals upon which he has mainly relied in the preparation of this "Aid" were made during his connection with Dr. A. Agassiz' Marine Laboratory at Newport, R. I., and the Museum of Comparative Zoology at Cambridge. He takes this opportunity to express his gratitude for the advantages afforded him at those places.

He has spent portions of four summers at Eastport and Grand Manan, and made frequent excursions to Provincetown, Beverly Bridge, Chelsea Beach and Ipswich.

A more complete list of the Actinoids and Echinodermata will be found in "Verrill's List," which has been of great help to the author in the preparation of this Aid, and for which he wishes to express his thanks.

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